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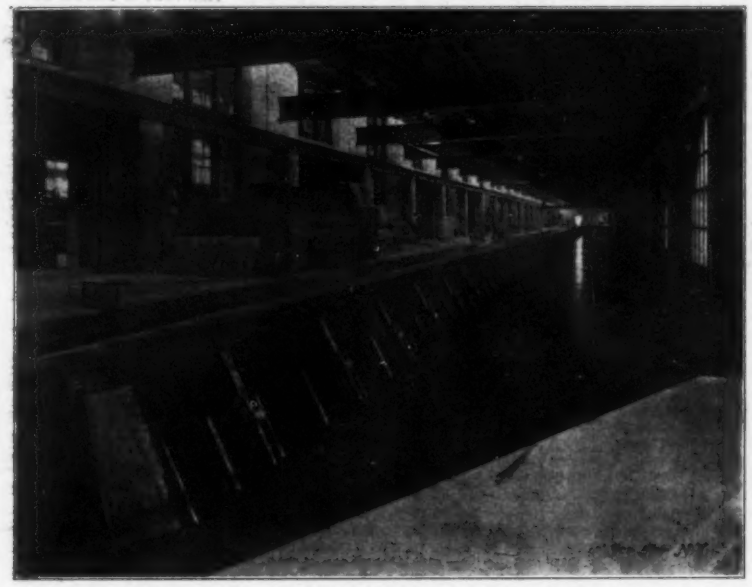
POWER-HOUSE NO. 2 AT NIAGARA FALLS.



INTERIOR OF THE COVERED FOREBAY OF POWER-HOUSE NO. 2.

INTERIOR OF POWER-HOUSE NO. 2 AT NIAGARA FALLS, SHOWING SIX OF THE NEW TURBINES.

THE NEW POWER HOUSE AT NIAGARA FALLS.*

By ORRIN E. DUNLAP.

THE Niagara Falls Power Company has completed the installation of the first six generators in power house No. 2, and while these machines are somewhat similar in outline to those erected in power house No. 1, they differ in appearance from the fact that the iron bridge over the machines in power house No. 1 has been omitted in building the machines in power house No. 2. This change is effected by placing the collector rings at the bottom of the dynamo shaft instead of at the top. The photographs reproduced herewith give a very accurate idea of the style of these new and notable generators.

Power house No. 2 is a beautiful building. Its exterior appearance is very similar to that of power house No. 1 with the exception that gables break the roof at the center and ends, adding beauty to the structure. The stone used is identical with that in station No. 1, and the general idea which won such favor in the original station has been carried out in this new power house. The new station stands on the opposite side of the inlet canal to that occupied by power house No. 1, and it is a little to the rear. It is built over a wheelpit that is 463 feet 8 inches long, 18½ feet wide, and 178½ feet deep. This new wheelpit is closer to the river than the old pit, but the two wheelpits have a connecting passageway at a depth of about 130 feet from the surface. The connecting tunnel is for the use and convenience of the employes. The new wheelpit has room for 11 units of 5,000 horse power each. The water from the second wheelpit installation is carried to the original main tunnel by an extension that is about 600 feet long, making the total length of the tunnel of the Niagara Falls Power Company 7,436½ feet. It will be recalled that this tunnel is built in form of a horseshoe, 21 feet high and 18 feet 10 inches wide, and is lined with brick from end to end.

In wheelpit No. 2 the turbines differ from those in wheelpit No. 1. When wheelpit No. 1 was built double turbines were installed, but in wheelpit No. 2 the turbines are of the internal discharge type and have the discharge water carried off through draft tubes, and this, it is stated, adds about 10 per cent to the effective head. These turbines were designed by Escher, Wyss & Co., of Zurich, Switzerland, but were built and installed by the I. P. Morris Company, of Philadelphia. The governors were built by A. Falkenau, of Philadelphia, but were also designed by Escher, Wyss & Co. These governors are of the oil-pump-operated type.

Although comparatively few years have passed since the development in connection with power station No. 1 was commenced, it is evident in the electrical equipment of power house No. 2 that electrical science has made notable advances in this brief period. There is closer generator regulation, the feeders are protected with automatic oil circuit breakers, and the 11 generators to be installed in power house No. 2 will all be controlled from a single switchboard, whereas power house No. 1 has two switchboard structures. The General Electric Company is furnishing the electrical equipment of this new power house. The generators are of 5,000 horse power each and are wound for 2,300 volts, two-phase, 25 cycles at 250 revolutions per minute. This makes it possible to have an interchange of service between power house No. 1 and power house No. 2.

This new station is to have two types of generators, the first six portrayed in the illustration being all of one type. These are of the external field type with nickel steel revolving magnet ring, but, as stated, the bridge over the top has been omitted. In the matter of regulation they are said to be nearly three times as close as those in power house No. 1, a fact that insures constancy of voltage under variations of load and also reduces to a minimum the unbalancing of the voltages on the different phases by the differences in loads. The system of ventilation in the new machines is also quite different. Actuated by centrifugal pressure, the air enters the machine at the bottom inside the armature shell. It then passes outward through air ducts in the armature core, cooling both the iron and the winding. Continuing, it passes radially between the layers of the field winding to an annular space in the rear of the field coils, then outward through holes in the magnet ring. Some of the air also passes through ventilating holes at the top of the ring.

*The five remaining generators to be placed in this station will be of the internal revolving field type, wound for 2,300 volts, 25 cycles, two-phase, and will be operated at 250 revolutions per minute. They will have the same regulation as the six already installed. Compared with the generators of external field design, these last five generators will cost less to build, will be more simple to handle, and the parts will be more accessible. It will be possible to operate all the machines in parallel.

In the construction of wheelpit No. 2 a compartment or chamber was excavated near the bottom, and in this the exciter plant has been installed. This equipment consists of four 150 kilowatt compound wound vertical shaft 220-volt exciters, each of which is coupled to an independent turbine. Each exciter turbine has a separate governor and the speed is 750 revolutions per minute.

The switchboard structure consists of a gallery located near the middle of the floor, and on it are mounted 36 separate controlling panels, 11 generators, 22 feeders, 1 exciter and two interconnecting panels. All the switching is done on these panels by means of relay switches, and these are placed in distinctive relation to one another and in such relation to imitation bus bars that the connections are clearly indicated, rendering it difficult to make a mistake. All the switches in power house No. 2 are of the General Electric electrically operated oil-break type, and all synchronizing is done by means of a Lincoln synchronizer.

One of the notable improvements in connection with power house No. 2 is the covered forebay structure built along the canal side of the main building. This is about 40 feet wide and extends nearly the entire length of the structure. All the racks in front of the penstock mouthpieces are thus under cover, the water entering the forebay from the canal through arches in the outside wall. This covered forebay structure will shelter the men working over the racks in winter, and as the water enters the forebay below the normal level, the system should be a protection from floating ice in the inlet canal.

William A. Brackenridge is the resident engineer of the Niagara Falls Power Company, and it was under his careful supervision that the great plant was erected. Mr. Brackenridge is thoroughly familiar with all features of the wonderful Niagara development, and to his ability as an engineer are due many of the improvements made in power house No. 2. Mr. H. W. Buck is the electrical director of the Niagara Falls Power Company, and to his skill credit must be given for important electrical features of great value.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

THE OLDEST BOOK IN THE WORLD.*

SOCIETY, ETHICS, RELIGION IN EGYPT BEFORE 2000 B. C.

PREFACE OF MONSIEUR VIREY.

ALL that is known of the origin and discovery of the Prisse Papyrus was made public long ago by Chabas in "Le Plus Ancien Livre du Monde, Etude sur le Papyrus Prisse," Revue Archéologique, 1858. I do not pretend to do anything more than give a summary of the statement by Chabas.

Prisse, who gave this papyrus to the National Library in Paris and published it in 1847 ("Fac-simile d'un papyrus Egyptien en caractères hiératiques," Paris, France), had obtained it from one of the peasants whom he employed on his excavations at Drah-abo'l-Neggah, in the necropolis of Thebes. This man pretended to have received the manuscript from a third person, who did not know whence it came; but Prisse suspected that they wished to make him pay for an article which already belonged to him, found among the excavations which were being made at his expense, and that the papyrus must have come from the tomb of one of the Entews of the eleventh dynasty. The large and solid character of the writing gives the impression of a date earlier, rather than later, than the twelfth dynasty (2,600 B. C.).

But if there is still uncertainty regarding the *time when the copy which has come down to us was made*, on the other hand, we know exactly to what date we can trace the *composition of the text*, and we know it from the text itself.

Our first two pages, in which we find some precepts concerning manners and morals, form a treatise which was composed in the beginning of the reign of the king Senoferu (third dynasty) [about 3,900 B. C.] by a man named Kakimna: "At this time the majesty of the king of the south and north, Huni, arrived in port [died]; then arose the majesty of the king of the south and north, Senoferu, a king beneficent over this whole land; then I, Kakimna, was made prefect." The last sixteen pages contain a treatise on morals composed by the prefect Ptah-hotep in the reign of Assa (fifth dynasty) [about 3,500 B. C.]: "Precepts of the prefect Ptah-hotep, under the king of the south and north, Assa."

The name of Ptah-hotep, common under the ancient empire, is found also in connection with the name of Assa, where he is called "the favorite of Assa, Ptah-hotep."

This Ptah-hotep is perhaps the author of our book, for he boasts of having been "favored by the king among the first of those whose works have made them noble." One passage seems to indicate that he was of a royal race, for he is called, "the son of the king, eldest, legitimate"; however, this last point does not seem at all certain. We might question why the eldest and legitimate son of the king did not reign, if he lived, and Ptah-hotep did not die early, since he was one hundred and ten years old when he wrote his treatise. To admit that he was the son of Assa, and that he died before this king, one must attribute to the latter an extraordinary length of life.

But Prof. Maspero has already shown that one must not take literally the titles of "royal mother, royal wife, royal daughter;" and that woman was a royal wife, for example, by right of birth, before marriage. These names served only to determine the rank which a princess occupied at the court in matters of etiquette and precedence.

If the name of royal wife was only an honorary title, I take this as warrant for supposing that one could be called a son of the king without really being one; and that the title meant "prince"; in this case "son of the king, great, legitimate," was equivalent to "prince of the blood." That this last name could have been given to a person not belonging to the royal family, is not without example in contemporary history, even in the West; there is all the stronger reason therefore that it might happen in the East, where high-sounding epithets accumulate so easily. At the Egyptian court, where the king was the source of all privilege, and all honors came from the king, perhaps all nobility consisted in attaching one's self, at least nominally, to his family, or in drawing near to it. The relatives of the king bore the highest title; but the "royal nurses" themselves, gloried in "the suckling which had mingled their blood with Horus."

Ptah-hotep, at the age of 110, after so many years of service, must have attained the highest dignities, and if the title of prince of the blood appears lofty, I remember that he was first among those whose merit had made them noble. Then enfeebled by old age, forced to give up the work which had made his glory, but unable to resign himself to live uselessly during the remaining days of his life, he resolved to write for younger generations the lessons of wisdom which he himself had received from the ancients, or which long experience had taught him. By a poetic fiction, he addresses himself to Osiris, depicts the miserable state to which old age and infirmities have reduced him, and asks if the god will permit an intelligent being to be condemned to be good for nothing. Osiris replies to his prayer and commands Ptah-hotep to teach the wisdom of the ancients which they learn from the gods.

Then Ptah-hotep begins to "set in order the good word," and sets it in order with a fertility of invention, the cause of which I will soon state. He has chosen his son for hearer; otherwise his doctrine is applicable to all men. After the explanation of his precepts, he returns more directly to his hearer, "If thou dost listen to what I have just told thee," etc.; and sings the praises of this doctrine. The *ma*, wisdom and knowledge, were acquired by listening with docility, for docility is the best of all. And since these old precepts are good, they must be held, and no one should teach new ideas. Undoubtedly some innovators will make themselves heard by the ignorant crowd (§ 42), and for a time inspire the public with confidence; but their glory will not last as long as they wish. Therefore nothing must be taken away, nothing added, nothing changed of the established teaching; and if anyone feels ideas contrary to these germinating in himself, he must beware of disclosing them.

This horror of new ideas and of innovators is interesting to see in the oldest book in the world; but one must not hastily conclude from this that Ptah-hotep was unfriendly to all kinds of progress. He himself says that "the barriers of art are not closed, no artist having attained that perfection to which he should aspire." Only the teaching of morals has been perfect from the earliest times, because it is of divine origin; therefore it must remain unchanged. But it is not forbidden to comment upon these established precepts; the author considers them a "canvas to be embellished," upon which the masters shall exercise their eloquence; but in order to comment upon them without falsifying their spirit, knowledge is necessary, knowledge acquired by application and docility. Again and again he insists on docility; the docile son who receives the word of his father shall live long for that reason, he shall please his lord and obtain favor of the king; on the contrary, the man without experience, who does not listen to the counsels of wisdom, goes astray and is on the road to ruin. And Ptah-hotep ends by quoting his own example: "I have reached one hundred and ten years of life, blessed by the favor of the king among the first of those who have exalted themselves by their works, doing the pleasure of the king, in an honored place."

As for these precepts, the study of which will be fruitful in its results, I shall not try to sum them up here. The work is so composed that such an attempt would lead me to bring into this introduction almost my entire translation; or else I would be obliged to limit myself to a simple list of titles which would not be interesting and would give the impression that the treatise is dry. On the contrary, it is a collection of counsels which, taken separately, are generally very well drawn up, but which follow one another without much order; when two of them can be connected it is because the author insists upon one idea and returns to it; but it is very hard to find any trace of method; still less must we look for the spirit of system, the well-ordered development of a philosophy, which one could grasp and epitomize. For this Ptah-hotep does not care; not that his work is slovenly; on the contrary, the style is very elaborate, sometimes even overwrought, and this leads me to speak of the difficulties of various kinds which embarrass the translator.

The subtlety of the style, which has been considered not the least of these difficulties, is due principally, I think, to the Prisse Papyrus having been written in verse; the oldest book in the world is a work, if not poetic, at least rhythmic. In this will be found the explanation of constructions which seem a little strained, for example: "While the father is in great sorrow, and the mother who bore him, another is happier than she." This shows us what Ptah-hotep means when he says that he "set in order the good word." But this order will aid the translator more than it will embarrass him, since the discovery by Professor Grébaut of the laws which regulate the poetic language of the Egyptians enables us to divide the phrases with certainty.

Another difficulty appears to be more serious; it is due to the use of a certain number of words whose exact meaning we do not know. Some of them, undoubtedly fallen into disuse at an early date, have never until now been met with in the other texts which we have. We may hope that fresh publications will bring us new examples of them. The Ebers Papyrus has given us some archaic words; and archaic terms may yet be found in the numerous texts of the old Empire which Prof. Maspero has published. Moreover, in spite of the beauty and the size of the writing, the text is not always as easy to decipher as one would think at first sight. There are passages of whose meaning I cannot be sure, because I have not yet been able to read them in an exact manner. Sometimes the writing is much abbreviated, which is very embarrassing in the hieratic. Finally, though the manuscript is in general well kept, it is not irreproachable. Thus, I have noticed evident faults, and I also think I recognize the omission of some words where the phrase seems to have no meaning and where the verse is too short.

In spite of many difficulties, this papyrus is so interesting that at an early date Egyptologists courageously undertook its study. Without pretending to reach by the first step complete and definite results, they could at least grapple with the subject, and it is no mean result to make known little by little, even imperfectly, a document of this value. Though Dr. Heath, who set the example in 1855, did not succeed in making Egyptologists accept his too bold interpretations, Chabas some time after was more successful. I have already spoken of his work published in the Revue Archéologique. Under the modest guise of an analysis, he gives a satisfactory translation of the first fourteen lines of the treatise of Ptah-hotep and of important passages from the latter part; the rest of the work is simply analyzed. This analysis was very incomplete; and by a partial translation one is liable not to grasp the exact meaning; nevertheless a great advance had been made. In 1869 and 1870, Lauth went further, and published a complete and coherent translation, accompanied by numerous notes. Such a translation must necessarily be far from perfect; but though one might make a number of criticisms upon this important work,

* The French Version of the Papyrus Prisse, by M. Philippe Virey. Translated by Professor Howard Osgood. The very obscure text of this manuscript has been often translated, but heretofore not satisfactorily. M Virey, while attached to the mission at Cairo, devoted six years to the study of the work and has presented a translation upon which little improvement can be expected. This version, turned into English, by Dr. Osgood, appeared in a recent number of the "Records of the Past" and we present here the introduction of M. Virey, together with portions of the work.

its merits must not therefore be forgotten. It has many times been very useful to me, and I should make a greater point of this here, if I did not have occasion to speak of it constantly in the course of my work. Finally, the translations of Brugsch are very ingenious and interesting, and I shall often quote or discuss them. I had composed this study before the work of Dümichen upon the first two pages of the papyrus appeared; the reading of his translation has not been useless to me, though mine had been finished long before.

Outside of the help furnished by the works of my predecessors, I have already said how much easier my task had been made by putting into practice the teaching of Professor Grébaut. But I wish at the same time to acknowledge what I owe to the masters who have, from the start, directed my studies; to Chabas, who, unhappily prevented by sickness from guiding me in the way which he had pointed out, did not cease to show me by many tokens of good will how much he was interested in my progress; and to Prof. Maspero, who, taking up again the teaching hardly commenced, has taught me to decipher, and helped me with advice and encouragement in the accomplishment of a difficult work on a newly discovered manuscript which I brought from Thebes.

THE BOOK OF KAKIMNA.—A TREATISE ON MANNERS IN THE TIME OF THE KINGS HUNI AND SENOFERU OF THE THIRD DYNASTY.

I am sure of being respected. A song that is right opens the stronghold of my silence; but the paths to the place of my repose are surrounded by words armed with knives against the intruder, no admittance except to those who come aright.

If thou sittest down to eat with a number, despise the dishes which thou lovest; it is but a short time to restrain thyself; and voracity is something degrading, for there is bestiality in it [comp. Ptah-hotep, § 7]. As a glass of water quenches thirst, as a mouthful of vegetables strengthens the heart, as one good takes the place of another good, as a very little takes the place of much, he who is drawn away by his stomach when he is not on the watch is a worthless man. With such people the stomach is master. However, if thou sittest down to eat with a glutton, to keep up with him in eating will lead afar; and if thou drinkest with a great drinker, accept in order to please him. Do not reject the meats, even from a man repugnant to thee, take what he gives thee, and do not leave it; truly that is disagreeable.

As for a man lacking good manners, upon whom all that one can say is without effect, who wears a surly face toward the advances of a gracious heart, he is an affliction to his mother and his relatives. All say: "Show thy name, thou whose mouth is silent; speak, be not proud because of thy strength."

Do not harden the hearts of thy children. Instruct those who will be in thy place; but when he does not permit, none knows the events which God brings to pass. Let the chief talk to his children, after he has accomplished the human condition; they will gain honor for themselves by increasing in welldoing, starting from that which he has told them.

If all that is written in this book is heeded as I have said it, in order to make progress in the right, they who heed will learn it by heart, they will recite it as it is written; it will do good to their hearts more than all things on this whole earth, in whatever position they may be.

Then at this time the majesty of the king of the South and of the North, Huni, arrived in port [died]; then arose the majesty of the king of the South and of the North, Senoferu, a king beneficent all over this entire land. Then I, Kakimna, was made prefect. It is finished.

THE PRECEPTS OF PTAH-HOTEP.

I.

The Precepts of the Prefect Ptah-hotep.

Under the majesty of the king of the South and of the North, Assa, living eternally, forever. The prefect Ptah-hotep says: "O god over the two crocodiles," my lord, the progress of time brings old age. Decay falls upon man and decline takes the place of novelty. A new misery weighs him down each day; the sight grows dim, the ears become deaf; the powers are constantly failing. The mouth is silent, speech is wanting, the mind flickers, not remembering yesterday. The whole body suffers. That which is good becomes bad, taste departs. Old age makes man miserable in every way; the nose is stopped, breathing no longer from exhaustion. In whatever position, this is a state (?) of . . . . (?) . . . . Who will give me authority to speak that I may tell him the words of those who have heard the counsels of former times? And the counsels of the gods which have been heard, who [will give me authority to tell them]? Let it be thus; let the evil of the *rekhi* be driven away; send the double . . . . The majesty of this god says: "Instruct him in the speech of former times. This it is that constitutes the worth of the children of the great. Whatever makes souls calm penetrates him who heeds, and what is thus told will not produce satiety."

II.

The beginning of the arrangement of good words, spoken by the noble lord, the divine father beloved of God, the son of the king, the eldest of his race, the prefect Ptah-hotep, as a means of instructing the ignorant in the knowledge of the choice of good words. There is profit to him who will listen to this; there is loss to him who will transgress them.

He says to his son: "Be not proud because of thy knowledge; converse with the ignorant as with the scholar; for the barriers of art are never closed, no artist ever possessing that perfection to which he should aspire. But wisdom is more difficult to find than the emerald; which is found by slaves among the rocks of pegmatite.

III.

If thou hast to do with a disputer while he is in his heat, and if he is superior to thee in ability, lower the hands, bend the back, do not get into a passion with him. As he will not permit thee to spoil his speech, it is very wrong to interrupt him; that shows thou art not able to be quiet when thou art contradicted. If then thou hast to do with a disputer while he is in his heat, act as one not to be moved. Thou hast the advantage over him, if only in keeping silent, when his speech is bad. "Better is he who refrains," says the audience; and thou art right in the opinion of the great.

IV.

If thou hast to do with a disputer while he is in his heat, do not treat him with contempt, because thou art not of the same opinion. Do not be provoked with him when he is wrong; away with that! He is fighting against his very self; do not ask him to flatter thy views. Do not amuse thyself with the spectacle which thou hast before thee; this is odious, small, and of a contemptible spirit. Struggle against this, as something condemned by the great, when on the point of giving thy views.

IX.

If thou art a farmer, reap in the field which the great God has given thee. But do not surfeit thy mouth among thy neighbors; it would be even better to make thyself feared by the possessor. As for him who, master of his own actions, all powerful, seizes like a crocodile in the midst even of the keepers, his children are by reason of that an object of cursing, of contempt, and of hatred; while his father is deep in trouble, and the mother who bore him, another is more happy than she. But a man becomes a god when he is chief of a tribe who has confidence in following him.

XIX.

If thou desirest that thy conduct be good and kept from all evil, beware of all fits of bad temper. This is a sad malady which leads to discord, and there is no more life at all for the one who falls into it. For it brings quarrels between fathers and mothers, as between brothers and sisters; it makes the wife and the husband abhor each other, it contains all wickedness, it incloses all injuries. When a man takes justice for his rule, walks in her ways, and dwells with her, there is no room left for bad temper.

XXI.

If thou art wise, take care of thy house; love thy wife purely. Fill her stomach, clothe her back; these are the cares (to give) to her body. Caress her, fulfill her desire, during the time of thine existence; it is a kindness which honors its master. Be not brutal; consideration will lead her better than force, her . . . this is her breath, her aim, her gaze. This establishes her in thy house; if thou repellest her, it is an abyss. Open thine arms to her for her arms; call her, show her thy love.

XXVI.

Do not disturb a great man; do not distract the attention of the busy man. His care is to accomplish his task, and he strips his body for love of the work. Love for the work they do brings men near to God. Therefore compose thy face, even in the midst of trouble, so that peace may be with thee, when agitation is with . . . These are the people who succeed where they apply themselves.

XLIV.

Do that which thy master tells thee. Doubly good is the precept of our father, from whose flesh we come forth. May what he tells us, be in our hearts; do for him more than he has said and satisfy him wholly. Surely a good son is one of the gifts of God, a son doing better than he has been told. For his master he does what is right, throwing his whole heart into his ways.

By following these lessons I secure that thy body shall be in health, that the king shall be satisfied with thee in all things, and that thou shalt gain years of life without failures.

They have gained for me upon earth one hundred and ten years of life, with the gift of the favor of the king, among the first of those whose works have made them noble, doing the pleasure of the king in an honored place.

It is finished, from its beginning to its end, according to what is found in writing.

CONTEMPORARY ELECTRICAL SCIENCE.*

PHÓTO-ELECTRICITY.—T. Wulf has devised a new lamp for photo-electric work which gives a powerful light containing a great quantity of ultra-violet rays. It consists of carbon bisulphide in a Mariotte bottle, which enters the wick of an ordinary petroleum burner and is mixed with oxygen introduced into the center of the flame. He studied the relations between chemical and photo-electric effects, and found that platinum electrodes with occluded hydrogen are highly photo-electric, whereas in oxygen, chlorine and ozone they become very insensitive. The effect of the medium surrounding the electrode is greater the greater the chemical difference of potential between the two. This matter is closely connected with the question as to whether the dissipation of electricity by light is connected with a chemical process. Lenard did not discover any appreciable decrease of the effect, even in the highest vacua, and this makes it probable that, if the gas plays any part at all, quite minute quantities suffice to produce the phenomenon. This is also shown by the following simple consideration: Supposing that with every electron one atom is moved, the transfer of a gramme-atom requires 96,450 coulombs, and of one milligramme-atom roughly 100 coulombs. The current strength proceeding from a photo-electric electrode is 10^{-5} amperes at the most, but more usually 10^{-9} amperes. Such a current would, therefore, require between 3 and 3,000 years to liberate one milligramme-atom.—T. Wulf, Ann. der Physik, No. 12, 1902.

REFLECTION OF ELECTRIC WAVES.—When electric waves are sent along two straight parallel wires, and a series of stationary waves is formed by reflection from the unconnected ends of the wires, it is found that the distance from the ends to the first node of electric force is less than a quarter wave-length as determined elsewhere along the wires, though one would expect to find a loop of electric force and a node of current at the ends. This discrepancy always appears, whether the measurements are made by means of a resonator or by the sliding-bridge method of Lecher. H. A. Bumstead shows that even with perfectly conducting wires, and without any modification of Maxwell's theory, or any assumption of the escape of charge into the air, a displacement of the current node beyond the end of the wires is to be expected theoretically, and that its magnitude should be of the same order as that which is found experimentally. With the resisting wires we have no longer strictly plane waves, as the electric force is no longer normal to the wires; moreover, the dissipation of energy does not take place throughout the plane, but in the wires alone, and unless the distance between the wires is small in comparison with the wave-length discrepancies must be expected. These can only be obviated by letting the wires end in a conducting plane normal to them. If they are bridged by a wire the reflection will be imperfect, even if all the wires are perfect conductors.—H. A. Bumstead, Am. Jour. of Science, November, 1902.

RADIOSCOPY.—E. Grunmach reports upon the progress made in the diagnosis of diseases of internal organs by means of Röntgen rays. Contrary to the prevailing usage, he recommends the use of large induction coils giving sparks 50 cm. or 60 cm. long, as these alone furnish reliable results. He even goes further, and employs a coil of 100 cm. spark worked from the Berlin electric light mains. Many applications of radioscopic methods have been made to the heart, and the author shows how the best radiograms may be obtained, and mentions that the subject should breathe naturally while they are taken. Incipient pulmonary consumption is indicated by the lung expanding less under the diseased clavicle than under the healthy one during inspiration, but as this is shown also in dry pleuritis and other affections, it is also necessary to observe the action of the diaphragm. It descends less during deep inspiration on the diseased side than on the healthy side. Gaseous and liquid gatherings, tumors and fibrous aggregations are easily discovered with the eye method. In one case described, the lung was seen to be pressed against the heart, and the liquid gathering was seen to break into waves with the movement of the patient. In another case an abscess in the brain was discovered owing to the calcareous infiltrations it contained.—E. Grunmach, Arch. d'Electr. Medicale, November, 1902.

BIPOLAR ELECTRODES.—A. Brochet and C. L. Barillet have continued their researches on bipolar electrodes, using this time a soluble anode. The copper anode and the cathode have the same surface as the section of the electrolytic cell in which they are immersed. It might be expected that the amount of copper deposited upon the intercathode should bear to the amount of copper deposited upon the cathode itself the same proportion as their respective surfaces. But, as a matter of fact, the amount is much more feeble. In such a system, since the weight of copper deposited upon the intercathode is practically the same as that dissolved away from the interanode, the bipolar electrode does not change in weight, and it is, therefore, not possible to find out what has happened by direct weighing. The author, however, obtained better results by mounting the two middle electrodes side by side and joining them with rubber rings. The best arrangement of bipolar electrodes is that in which they fill up nearly the whole cross section of the cell, since there is no action upon them for about 1 cm. inward from the margin all round. Generally speaking, it is profitable to employ pieces of metal not connected with the electrodes, and these may be either soluble or insoluble.—Brochet and Barillet, Comptes Rendus, December 8, 1902.

MAGNETIZATION OF LIQUIDS.—G. Piaggesi has endeavored to decide the question as to whether the magnetic susceptibility of liquids changes with the temperature, and has incidentally arrived at some interesting conclusions. The diamagnetism of water decreases as the temperature rises in a linear manner. The value of the magnetic susceptibility was found to be -0.77×10^{-6} at 23.3 deg. and -0.68×10^{-6} at 85.4 deg., and generally can be expressed by the equation

$$k = -0.804\ (1-0.00175t) \times 10^{-6}.$$

Hence there is here a distinct influence of the temperature, though only a small one. The magnetic susceptibility of a solution decreases as the temperature rises. The temperature coefficients are nearly the same for all solutions studied, including nickel chloride, cobalt chloride, manganese or iron chloride, sulphate and nitrate, and are of the same order as the coefficient of expansion of a gas. The product of the magnetic susceptibility into the absolute temperature is a constant whose value depends solely upon the nature and the concentration of the solution, in accordance with the law discovered by Curie for oxygen and for an aqueous solution of ferrous sulphate. The product diminishes as the solution becomes more concentrated.—G. Piaggesi, Nuovo Cimento, October, 1902.

RAYLEIGH'S PHASE-METER.—Lord Rayleigh has described an instrument for measuring the angle of lag of an alternating current behind the E.M.F. impressed at the terminals of the circuit (see The Electrician, June, 1897). With proper calibration the readings gave also the current, E.M.F., and thus, generally, such quantities as apparent watts, true watts, power-factor, induction, I^2R loss and hysteresis. E. S. Johonnott describes an instrument constructed after Lord Rayleigh's pattern and suitable for the use of students. The instrument consists of a current coil and an E.M.F. coil, with a piece of soft iron wire 1 cm. long suspended by means of a phosphor-bronze torsion wire at an angle of 45 deg. to the common axis of the two coils. The soft iron wire represents the needle, and its deflection, which is proportional to the mean square value of the current, is read by means of a mirror attached to it. The author describes two arrangements. One is that of "parallel coils," in which two strands of wire are wound simultaneously on the same form, one constituting the magnetizing and the other the exploring coil. In the arrangement of "distributed coils," 10 small coils are distributed on each half of the split iron anchor-ring. The latter arrangement gives the best results.—E. S. Johonnott, Phys. Review, November, 1902.

ELASTICITY OF GLASS IN AN ELECTRIC FIELD.—The electromagnetic properties of glass have hitherto been chiefly studied in connection with the Kerr effect.

* Compiled by E. E. Fournier d'Albe in the Electrician.

But in order to arrive at a clear conception of dielectric polarization, it would be desirable to investigate the effect of an electric stress upon the mechanical properties of glass. So far, we have practically nothing but Quincke's work on the torsion of tubes of glass in an electric field, which showed an apparent stiffening. G. Ercolini has, therefore, taken up the question systematically, and studied the elasticity of glass under flexure, compression, and traction. His results have been distinctly negative, no effect of electric stress upon the elasticity having been observed, even with the most sensitive arrangement. In all the experiments, the two terminals of a Voss machine were connected with the coatings of a narrow cylindrical condenser made of the glass to be experimented upon. In a branch circuit was inserted a spark micrometer with a very fine brass point, a condenser of eight large Leyden jars and an electrometer. The difference of potential between the armatures of the condenser was made such as to give a spark of 2 millimeters between brass spheres 2 centimeters in diameter. The readings were made by an interferometer method. Here are two series with a flexure load of 50 grammes: charged, 202.8, 200.0, 201.3, 203.6 divisions; discharged, 201.5, 200.5, 202.0, 202.3 divisions.—G. Ercolini, Nuovo Cimento, October, 1902.

THE SERPOLLET STEAM AUTOMOBILE.*

III. THE PUMPS AND OILER.

THE 12 horse power Serpollet steam carriage is fitted with four pumps—one, a hand air pump (*P*, Fig. 3) for setting up a pressure in the gasoline tank in order to force fuel to the burner when starting or coasting down hill; the second, an automatic fuel pump to force fuel to the burner when running; the third a similar water pump, for supplying the generator with water; and the fourth an auxiliary hand water pump, used only occasionally for starting.

The hand air pump is shown in Fig. 2. It has a pet cock on the bottom, in the movable plug of which is a small hole, *b*, at right angles to the regular hole, and situated so that when the pet cock is in the third or lower position, the hole, *b*, will coincide with the hole, *a*, in the casing, and allow air to escape from the tank into the atmosphere, thus lowering the pressure on the gasoline and cutting down the flame in the burner, if the carriage is to be left standing. In the first position shown, the valve connects the tank with the pump; in the second, it shuts it off from the pump, and in the third, it releases the pressure.

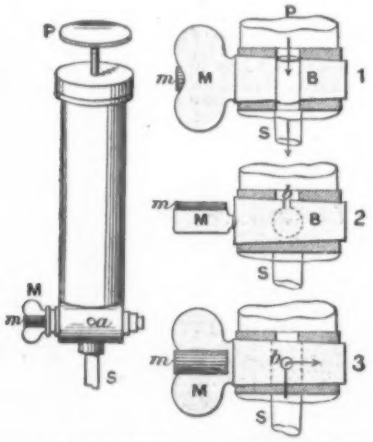


FIG. 2.—HAND AIR PUMP AND CROSS SECTIONS OF PET COCK.

The regular gasoline feed-pump, driven from the cams shown in Fig. 1, is seen in section in Fig. 4, where *J* is the driving cam, and *H* the roller on the double or forked lever arm, *E G*, which communicates its reciprocating movement to the piston, as shown. The piston, on its suction stroke, raises valve *S*, and draws in a charge of gasoline. On its working stroke, it forces this out to the burner through valve *T*, while the pressure is indicated on gage *B*. As the two valves open in the same direction, they are forced open by the pressure in the gasoline tank when valve *D* (Fig. 3) is opened; and thus the pressure in the tank forces gasoline to the burner when the pump is at rest, while this pressure is shown on gage *A*.

The illustration, Fig. 1, shows the frame on which are mounted the water and fuel pumps, *P p*, the oiler, *N*, and the cams, *L*, for driving the pumps. The stroke of these two pumps is varied by cams of varying eccentricity, squared on a cam shaft in such a way that they can be slid along it and different ones

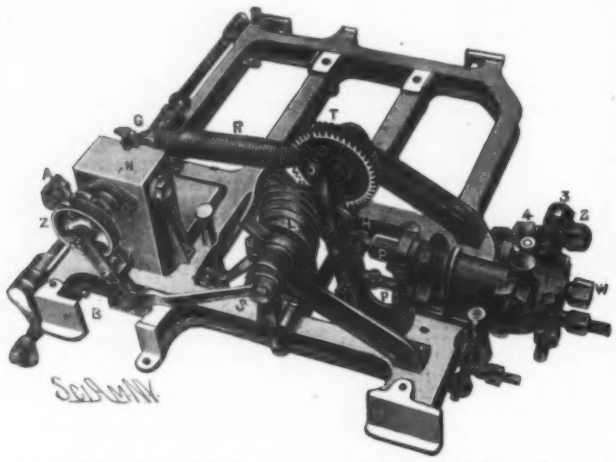


FIG. 1.—FRAME CARRYING AUTOMATIC PUMPS AND OILER.

be made to engage the roller, *H*, thus pushing to one side the double lever arm that carries it and to which the pump plungers are fastened. The spring, *R*, draws back the lever arm, which pulls out the two pump pistons on their suction strokes. The gasoline pump has a smaller bore and stroke than the water pump, but its stroke is increased in the same proportion as that of the latter, and hence the fuel is always fed to the burner in proportion to the quantity of water to be vaporized.

The pump cams are formed on a single block of

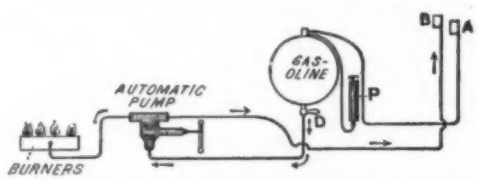


FIG. 3.—DIAGRAM OF FUEL SUPPLY SYSTEM.

steel, thoroughly hardened, and capable of being shifted on the cam shaft by a suitable guide connected by levers to a handle on the steering post. This block of steel is cut to form six cam surfaces, all but the first of which are eccentric to the shaft on which they are mounted. The cam 1 (Fig. 5) is eccentric to the disk 0 to a certain extent, while 2 is eccentric to 1, 3 to 2, 4 to 3, etc., in a similar ratio, so that cam 2 gives double the stroke to the pumps given by cam 1, cam 3 triple, and cam 5 quintuple. Cam 5, therefore, sends four times more water and gasoline into the generator and the burner, than does cam 1.

When the roller, *H*, is on the 0 disk, the pumps of course are not working. This is used when coasting, etc., the fire being kept going meantime by the reserve pressure in the gasoline tank.

It will be noticed that the cams are rounded slightly on their edges, and hollowed in the center to receive the roller, *H*. They can only be shifted when the motor is running and when the roller is at one of the two points, *Z Z* (Fig. 5).

The mechanical force feed lubricator of the Serpollet car is seen at *N*. It consists of a reservoir portion on top, in which is a fine wire gauze filter. The oil percolates through this filter, into the bottom part of the tank, from which it is forced into the engine. (The tank and all the other parts are seen from below in Fig. 1.) The driving ratchet wheel, *Z*, is moved a certain number of teeth each revolution of the cam shaft by means of a ratchet in the fork, *B*, which is given a reciprocating motion by the connecting rod, *S*, from a crank on the end of the cam shaft. The throw of the fork, *B*, can be varied by fastening *S* at different points in the slot in it. The ratchet, *A*, serves to hold *Z* from slipping backward.

The interior mechanism of the oiler is simple. It consists of a chamber and tube in which is the rotating and, at the same time, transversely moving piece, *H I S O* (Fig. 6). The ratchet wheel, *Z*, drives this rotating piston by means of a pin, *n*, on shaft, *B*, as clearly shown, while its side movement is given it by means of a cam, *I*, abutting against a bracket, *J*, in the case. A stiff spring, *R*, keeps the cam in contact with *J*, and hence moves the piston back again, after it has been crowded to the left. The piston is divided by a diaphragm, *S*, and has in its outer end two slots, one straight (*O*) and the other spiral (*L*). When the piston is in the position shown in Fig. 6,

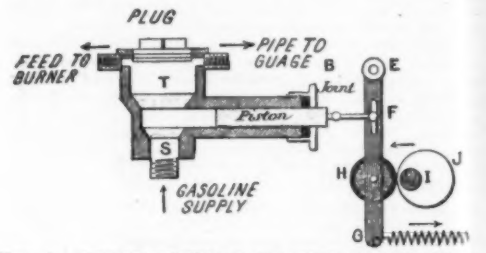


FIG. 4.—CROSS SECTION OF AUTOMATIC FUEL PUMP.

the oil flows into it through passage *K* and slot *L*. Then, as the piston is crowded to the left, this slot is covered, and the oil is put under pressure between diaphragm *S* and spring piston *T*. At this time the revolution of the piston brings slot *O* successively in communication with the three oil tubes, *a*, *b*, *c* (Fig. 7), and causes the oil to be forced out through them. Tube *C*, which connects with the steam pipe through nozzle 4 of the cross 1, 2, 3, 4, is fitted with a valve, *v*, to keep the steam from blowing back into the oiler. There is also a second valve near the cross.

The spring pressed piston, *T*, has a sufficiently strong spring to overcome the steam pressure in the generator. This piston is made necessary because of the incompressible nature of oil, and the fact that if something did not give when the piston is being thrust to the left and while the slot *O* is between outlets (as shown in Fig. 6), the apparatus would break. It is for this reason that the inventor has arranged a movable end in this chamber where the oil is compressed momentarily but vigorously. *T* is forced back against its spring when the slot *O* is not over an outlet, but it springs out again as soon as *O* coincides with *a*, *b*, or *c*, and helps force the oil out. Should oil escape past piston *T* and fill the chamber *Y*, thus making the movement of *T* impossible on account of the incompressibility of the liquid, the oil would be forced back into the reservoir through the passage, *U*.

The three oil pipes (Fig. 7) run, the first, *A*, into the top of the crank case, where it oils the cam shaft; the second, *B*, into the lower part of the crank case, where it keeps up the level; and the third, *C*, into the nipple, 4, of the cross 1, 2, 3, 4, where it feeds oil with the steam into the two pairs of cylinders, and thoroughly lubricates the pistons.

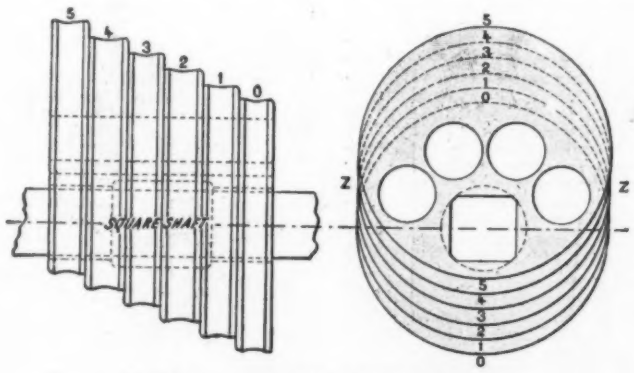


FIG. 5.—DIAGRAM OF PUMP CAMS.

[Concluded from SUPPLEMENT No. 1431, page 22935.]

DOMESTIC LIFE IN INDIA.

By JOHN DAVID REES, C.I.E.

THERE is no need to dwell on the ceremonies which attend the disposal of the dead. The sick man in his last moments if lying on a couch or bed is lifted therefrom that he may die upon the earth or beside the river, after receiving the last sacrament, composed of products of the sacred cow.' This practice is founded partly on the necessity which exists for dying on the bosom of Mother Earth, and partly on the need for avoiding the pollution which attaches to a house in which a death occurs. The chief mourner is son, father, brother, in the order given, or in the case of a woman, her husband, and he performs a sacrifice of fire before the body is borne by the caste fellows of the deceased to the burning ground, where a funeral pyre awaits the corpse, made up in the case of a poor family, perhaps, by contributions of a few sticks from neighboring houses. The chief mourner takes upon his shoulder a pot of water, and, after walking three times around the blazing pyre, dashes it upon the ground. In the case of castes who bury their dead, which all do in certain cases, a different ritual prevails, and, as might be expected from lower castes, it is less elaborate than that of cremation. The same distinction applies to the periodical ceremonies for deceased ancestors, which are performed in India, as in China, though in a lesser degree. As a result of such prayers and cere-

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT, from a Description by Mons. L. Baudry de Saunier in La Locomotion.

monies, the spirit of the deceased is provided with a temporary body, and without them it would wander about as a malignant ghost. Next, the temporary body is exchanged for an ethereal envelope, and either passes into the ancestral heaven, there to remain until absorbed into the divine essence, or, as is more widely held, receives judgment according to its works in the world, being reborn after a longer or shorter period spent in the purgatorial heaven or hell; to again accomplish a mortal life in another guise, until at length it qualifies for Nirvana, or absorption in the supreme essence.

"The Hindus believe in a Supreme Being, the immortality of the soul, and the necessity for, and existence of, another life in which sin and virtue meet with their reward.

In the *Sama-Veda* a typical man of sin is described, his head Brahmin murder, his eyes liquor-drinking, his face theft, tutor-slaying his ears, woman-killing his nose, cow destroying his shoulders, abduction of another's wife his chest, oppression of the innocent his stomach, while smaller sins are apportioned to the lower limbs. He is tall, bright-eyed, black, and malevolent.

In the Institutes of Manu, the body is compared with a house, in words which may be thus translated—

"Bones are its rafters and its beams,
Tendons and nerves, its scores and seams;
Blood is its mortar, and the skin,
Frail covering, roofs the mansion in.
Its occupants are age and woe,
Death and decay, as sure as slow;
Right gladly should the vital spark,
The soul, renounce a home so dark.
Birds at their pleasure quit the tree,
Who leaves the world alone is free."

Are we to assume, then, that life in the Hindu home is sad and wanting in brightness? By no means. Captain Temple thus described it in the paper he read before this society, but can those whose tents have often been pitched by the village well agree with him? Let a talented Mahratta lady, Miss Bhor, speak for Bombay, and note what she says of purdah, in passing. The Madras Hindu's report runs:

"It is usual to suppose that Hindu women are everywhere immured in the prison of zenana life, without hope of light or movement, and that they are actually nothing but birds kept in a cage. Their life is supposed to be one round of unrelieved gloom and misery, little better than the lot of old-world slaves, consigned to drudgery and even to solitary confinement in unwholesome dungeons. This figment of an unwholesome and diseased imagination has been repeatedly exposed, but it has lived on and flourished. Miss Bhor boldly tells the truth, and we hope she has killed this dragon of interested falsehood. She spoke thus: 'In those parts of Western India where the Mohammedan invasion very slightly affected the older Hindu customs, the Brahmin and other high caste women neither veil themselves nor live in seclusion; and at parties have as merry time as the men, though they do not mix with them. Women's parties from which men are excluded are often very pleasant. Hindu women and their families often go on pilgrimage, as when some member of the family sickens, or a girl becomes morbid and fancies herself possessed by an evil spirit. The journey is a rough but healthy experience, shaking the travelers out of the monotony of their daily lives.' What is true, thus, of Western India is true also of Southern India. Here, too, we have no veils, nor our women kept in enforced seclusion within a prison-cage. Here, too, women freely move abroad and can be seen in the street, market, river-side, or temple, as cheerful and sometimes even as vocal as any member of the sterner sex, and this, too, not only among the lower but also among the higher classes of society. Miss Bhor says truly that 'on the whole the Hindus are of a kind and cheerful nature which is reflected in their home life.'

Bhor writes as follows: 'The system of child-marriage is bad and brings in its wake worse evils; but given a bad system, it is worked out on the whole in a kind of sensible fashion.' She, again; speaks sensibly and truthfully on the system of compulsory marriage: "Though marriage is obligatory on every Hindu man and woman—no choice is allowed to man or woman in the selection of a partner—but it causes less unhappiness on the whole that married girls should be taken to their new homes, etc.' This system of girls being taken immediately after marriage to

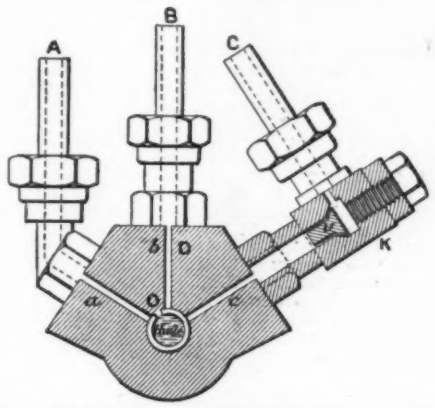


FIG. 7.—THE THREE FEED PIPES OF OILER.

their new homes prevails only in some parts of India, and even there Miss Bhor says that 'it causes less unhappiness on the whole.' In Southern India, this custom does not prevail. The girls remain with their parents till they grow up and even longer, and so the system of child-marriage loses its darker features a good deal in this part of the country. But we still hold firmly to the conviction that the system is 'bad,' and that it must be improved so that we may return to the old Shastraic institution of marriage after puberty. On this, and cognate questions, Miss Bhor writes very sensibly, and in weighty language: 'Freedom and choice are not recognized in the Hindu system for women, at all; and for men very slightly. And yet Hindu marriages turn out happy much oftener than might be thought possible in such circumstances, and no doubt in far away ages the system was not meant to press so heavily on women as it does now. Child-marriages were then unknown, etc.'

"Even as regards the question of child-widows, while condemning the institution in strong language, Miss Bhor admits that 'in the working out of this iron caste system there is much real heart and tenderness which softens for many its cruel decrees.'"

Meadows Taylor thought the Hindus "as courteous and intelligent a people as any in the world; kind to their children, respectful to their parents, charitable, honest, industrious, and with such vices as are common to human nature." He denied that they were untruthful and saw in "caste the means of enforcing the at least outwardly moral conduct of members."

Dr. Oldfield came back the other day from India, and said with all truth that the village folk were industrious, cleanly, thrifty, and simple in their lives, that the women are engaged in housewifely duties from morning till night.

See, too, how Mr. Dutt, when he soars above the exigencies of the platform, describes "the grateful people of India, their courtesy, frugality, charity; their dislike and distrust of the rapid introduction of modern Western methods; their love of living their

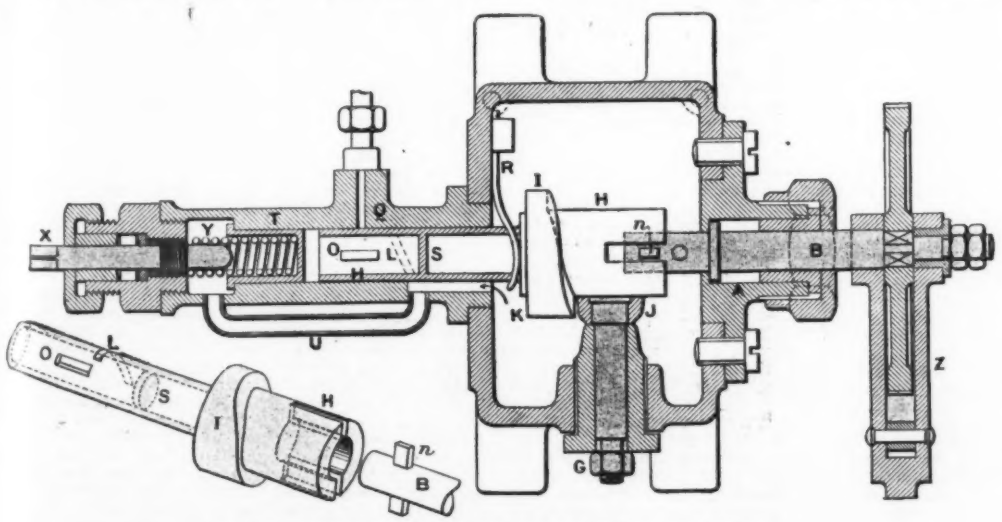


FIG. 6.—CROSS-SECTION OF OILER FEED CHAMBER.

"Let us next see what Miss Bhor has to say on the Indian system of child-marriage. We have always spoken candidly on the evils of the system, but even here there is such a thing as moderation and restraint; and Miss Bohr, while condemning the system as mischievous, exercises an admirable caution and good sense which others will do well to imitate. A good cause is often injured by extravagance and violence of language, and ardent minds always become victims of a disordered imagination which sees things as through a magnifying glass which distorts the true proportions and creates monsters and hideous shapes out of all relation to the realities around us. Miss own lives, their own way, in their own villages; their dislike of the alienation of their chiefs and rajas, who cease to live and move among themselves and become strangers among their own people." Carried away by this faithful and eloquent description he says, as Mr. Ramakrishna said: "There is not on the whole earth a more frugal and more contented peasantry." Even Abbé Dubois, who takes an unfavorable view of the Hindu character, says: "Animated in this behalf by the purest and noblest sentiments, the Hindus consider a man happy in proportion to the number of children he possesses, children being considered the blessing of a house." Those who have

ears for the merits of a multitudinous people should also read what Sir T. Monro, Sir J. Fayrer, Sir J. Malcom, Prof. Max Müller, and Sir W. Sleeman say in their favor.

The Dewan of Travancore well says that the Hindu home is founded on the basis of religion, in which a Hindu lives, moves, and has his being. The father is the guardian, preceptor, and patriarch, the woman protected by her male relations, and always married; nor looking at other countries where celibacy is practised by women, can he consider universal marriage altogether a curse. The decay of marriage marked the decline of the Romans and Greeks, and the Dewan would adhere to the high Hindu standard, merely postponing the ceremony till the latest permissible period. "The present system produces wives who in all that goes to the happiness of the husband and the peace of the home cannot be surpassed." "There is great misapprehension," says the Dewan, "among European nations regarding the purdah. There is no slavery or tyranny, and as families rise in the world their females ask for the privilege of the zenana system."

Mr. S. E. J. Clarke, a well-known authority on Indian life, said before this society seven years ago that Hindu women are distinguished for intense religious feeling, and would deem the freedom enjoyed by English women a degradation, and a willful abandonment to temptation.

Mr. Padfield, a distinguished writer and authority on Indian life, himself a missionary, says: "Habit and custom are much, if not everything, and certainly many a Hindu home is happy in spite of what may seem to us its dullness and monotony." Mr. Crooke says: "The North Indian peasant's life is one of ceaseless toil, but it enforces industry and temperance, and is compatible with a ready cheeriness, which can find amusement in the veriest trifles. It would be a great mistake to suppose the wife of the peasant to be nothing more than a drudge. Nothing in the house is done without her knowledge and advice, and she is not worse off, perhaps, than her sisters in a similar grade in other parts of the world."

Such as they are, husband and wife, they are likely to remain, unless unforeseen developments occur in the industrial potentialities of the country, for it is curious to find two authorities, neither of whom can well be surpassed, Abbé Dubois and Mr. Crooke, in the beginning and the end of last century, saying in almost identical words, that to imagine that the State can permanently improve the condition of the depressed classes is the dream of an enthusiast. A reduction in expenditure, and a respite from the perpetual increase of administrative charges for the furtherance of progress in Western civilization, whether needed or not, whether acceptable or not, whether suitable or not, would hardly affect the lowest classes to any very great extent, for they do not as a fact groan under a cruel salt tax and an excessive land rent.

No account of Hindu domestic life would be acceptable in this hall which did not touch upon some of the current problems of social reform, or, rather, upon the aspirations of the reform party. Novels appear from time to time written with the object of showing the need for protecting women behind the purdah, and suggestions are made that the Indian Government should create appointments for legal ladies who should tender advice to purdah women. It is, however, an altogether unfair assumption that purdahnishins are generally unfairly treated, and the intrusion of a stranger armed with official credentials, and very likely of a different race, religion, or caste, into the Hindu home would not conduce to its greater harmony and happiness.

Mr. Kipling says: "Even purdah women have always been in business touch with a thousand outside interests." Mr. Crooke in his work on the North-West Provinces, that part of India in which the need for legal advice is said to be particularly urgent, says: "Women exercise wide influence and control, whether within or without the zenana, and little that goes on outside escapes their ears." Mr. Crooke's book is one of the best ever written on India, and the Pioneer, knowing something of the United Provinces, observes that even if such appointments were created, "it by no means follows that they would be popular with the class in whose interest they are made." The purdahnishin lady can teach most people points in the law; she has already very substantial legal protection, and very much is presumed in her favor. Ninety per cent of the purdah women in the North-West Provinces know that they are so safeguarded.

It is not clear then why the Pioneer, while remarking that such a change should not be made off-hand, though supported by a certain number of High Court Judges, approves such a proposal, except that anyone who does not support every "emancipated" or "advanced" measure of reform is relegated to the black list of the reactionaries. The Hindus, their pockets, and their wishes, fall into the background when proposals (for which they alone pay) are put forward with influential support. It is also noteworthy that the actual proposal made is to provide for just such ladies as enjoy the protection and guardianship of the Court of Wards, viz., the Collector of the district, and are the least helpless of a by no means helpless class. Is it, again, true that, "among Hindu women, all but the lowest class of servants," are secluded in North and North-West India, a statement made, and widely repeated in the English press? Mr. R. C. Dutt, in the "Lake of Palms," says the custom prevails "chiefly in the towns of Northern India, where the rule of the Moslems lasted for centuries." Mr. S. E. J. Clarke said the same of Bengal, and apparently of all India, viz., that women of the laboring and agricultural classes move freely about, and living away from towns are not under the custom of the purdah. "Girls," says Mr. Clarke, "are by precept, instruction, example and discipline, taught a high ideal of womanhood. Even purdah women go on pilgrimages, entertain and visit their friends, and see a great deal of the outer world, of which they want no more than they have. I deny that Hindu women have necessarily a miserable life, and must bear testimony to the happy side." Abbé Dubois's evidence is this:

"Quiet and retired as is the life of Hindu women, it cannot be said to be one of complete or rigorous exclusion."

Mr. Crooke, writing of the North-West (now United) Provinces, says: "The prevailing note of village life is the absence of domestic privacy, and the publicity amidst which the people live. There is an utter lack of seclusion, except for women of the higher classes, and even among them the isolation is much less stringent than is supposed. Even behind the gloomy inclosure of the zenana wife and mother crave for gossip, and little that goes on outside escapes their ears. In the general management of the household they exercise wide control and influence. This is still more marked in the family of the peasant."

I quote at this length from Mr. Crooke for the North-West Provinces, and Miss Bhor for Bombay, because Miss Sorabji in a recent letter to The Times dwelt upon the prevalence of the purdah in these provinces.

The Madras Mail, one of the first English papers in the country, speaks well of the proposal, but points out that the aid wanted by purdahnishins is non-official aid, and that the practical difficulties may be insuperable. But the Hindu, one of the first Indian papers in India, scoffs at the idea that lady lawyers will be better than the existing male advisers as to ability and honesty, and asks why ladies, who are strangers to the manners, languages, and customs of the folks they are to help, should be able to help them. The Hindu says the whole scheme is impracticable, and that, as a fact, purdah ladies know the law very well, can manage their own affairs, and would object to "an expensive incumbrance to an already expensive administration."

The analogy of Lady Dufferin's Fund, which has been cited, is wholly untenable. That is a voluntary association to afford medical aid to women who otherwise would get none. The purdahnishin scheme is to assist female proprietors with official legal advice, which they can get, when they are disqualified from the management of their estates, at the competent hands of a Court of Wards provided by Government, and fully equipped with legal advice.

The Dufferin Fund has done immense good, and no one knows that better than one who was for many years a Presidency Branch Secretary. But its successes have not been among purdahnishins. I pointed out in its early days, in one of the English reviews, that this must be so, and the Amrita Bazaar Patrika recently described the Fund as "based upon the fiction that purdahnishin ladies are not allowed in Bengal by their husbands to be treated by male doctors. Purdahnishin ladies are not in need of any special assistance, nor poor men in towns, but let the poor in the interior, male and female, have medical relief. There is no objection whatever on the part of Hindu or Mussulman ladies to be treated by male doctors. Hence Gosha hospitals built in towns remain unoccupied." They do for the most part, and the good work is done elsewhere, but the circumstances illustrate the ignorance and exaggeration of which the purdah system is fated to be subject.

The Hindu Patriot also recently pointed out that while the Fund had amply justified its existence, now that more than one and a half millions of women are treated by women owing to its efforts, it has and must fail in its efforts to induce purdahnishins unnecessarily to go to hospitals.

There is no end to the error which prevails and is fostered as to the extent and the evils of the purdah system. A recent writer, whose "Kamala's Letters" has attracted a great deal of attention, makes one of his female characters say: "The purdah does not exist in Hindu society except where wealth holds despotic sway. Where elsewhere it is found it is due to the new products of English education, who, rising in rank and position, under false notions, have taken to it." I would not accuse English education in this respect, but it is well to see the view held by the other side, just as profit may be extracted by reading in the Bengalee that "Englishmen are passionately fond of horses, which they value as highly at times, or more highly, than women. Who ever heard of 37,000 guineas for a racehorse, the price paid for Flying Fox?" What will the Hindus think of a question in the House of Commons suggesting the provision of legal advice, at the public cost, for purdahnishins, "the first object," as Mr. Crooke points out, "of a man who has obtained a fairly respectable social standing being to seclude his women"?

The extent to which missionary teaching has directly affected Hindu domestic life is not so great as is sometimes represented. Even Keshub Chunder Sen, who, among many other extreme and exaggerated faiths, held "that Christ, with an army of missionaries, and not the Government with an army of soldiers, ruled British India," protested "against the denationalization so general among native converts, who abandon the manners and customs of their country, and so are estranged from their countrymen, forgetting that Christ was an Asiatic." Little, however, can be based upon the rhapsodies of a prophet who at one time inveighed against "the spiritual and moral destitution of India, the reign of idolatry and the tyranny of caste," and at another dwelt upon "the extreme spirituality of the Indian nature, and the unfortunate results of breaking down by extraneous influences the caste system which is the framework of Indian society." Miss Noble, who has become a Hindu, is as good an authority on Hindu social life as Indian ladies who have become Christians, and she says: "From my own experience I can refute the charge of oppression of Indian women often leveled against Hindus. The crime of ill-treating women is at once less common and less brutal in form in India that in younger countries. Indian national customs require no apology."

It is a remarkable fact that while twenty-five years ago all the English-educated were reformers, by profession at any rate, a strong Hindu revival has characterized the last fifteen years, and at present an almost reactionary movement prevails, whether due or not to the teachings of the Brahmos and Theosophists of Mrs. Besant, Miss Noble, and Swami Vivekananda, to the effect that ancient Hindu ideals are all that can be desired. At any rate, when Miss Noble, or Sister Nivedita, says, "Where women unselfishly serves her dear ones from morn to dewy eve, domestic happiness is most often found," there will be few to gainsay her; and those who are most familiar with Hindu customs and languages, a necessary equipment for a knowledge of their domestic life, will recognize as true to the letter her description of Indian women, whose traditional virtues it is ridiculous to ascribe, as Baboo Mozoomdar did in London, to a conscience awakened by religious instinct due to a foreign rule, or to the influence, however good it may be and is, of a Christianity which that foreign rule is pledged not to force upon its Indian subjects. The Bishop of Madras lately characterized as too sweeping the statement of the late Bishop of Calcutta to the effect that no Hindu or Mohammedan student goes through a university course without having his religious belief destroyed or seriously impaired, and he said, as the Viceroy has, that there is a great danger in the present divorce between education and religion in India, adding that this is inevitable so long as religion in India takes its stand on tradition, and refuses to submit to the demands of criticism—a position I understand to be characteristic of true and orthodox churches elsewhere. At any rate we can say, as the Novoe Vremya said the other day of the Russians in China: "We are strong in these regions in proportion as we do not interfere with the religious convictions of the native population."

Religion is caste and caste is religion, and the Hindu newspaper, and the great reformer, Dr. Bhandarkar, seem to agree in thinking that the caste spirit increases with the spread of English education. The doctor says: "In my early days all classes joined in a public movement, now Hindus, Mohammedans, and Parsees act independently, and even separate castes. There is greater estrangement than existed before social reform was thought of." The revolt against the Gains of Learning Bill, which the small class of highly-educated lawyers sought to rush through the Madras Legislative Council, is a significant proof of the truth of this opinion. The measure would have proved a powerful solvent of the caste system, and the Hindu home, with its joint family earnings. The Maharaja of Jeypore's recent justification of his caste-preserving attitude in England, and his public profession of partiality for "old customs and traditions on which the foundations of the Hindu religion are based," is another straw showing which way the wind blows.

This purdahnishin protection movement focuses the very feelings against which a strong reaction exists.

Of course, the idea that purdah ladies will not see male advisers, influences those who support the proposal, and, of course, the idea is based on error.

Foreign observers see something of the facts. Prince Okhtomsky, who found fault with most of our proceedings, has a good word "for the kindly tolerant and amiable Hindu, and their loving wives and mothers." The author of "Kamala's Letters to her Husband," says by one of his characters: "Though it is the policy of our rulers not to interfere in our social and religious matters, it seems to me they do so when they choose. Much in our systems which may appear intolerable and unreasonable to a few, cannot be altered without interfering with the very character of our social fabric. There is no commoner fad of our hybrid products of English education than their twaddle about the cruelty of caste."

As a fact, at present, the more disagreeable incidents of the ceremony of readmission of those who have lost caste in England, are being abandoned, and a Brahmin of high position recently had his offense condoned at the cost of a dinner party to brother Brahmins, and a bath in the sacred sea. The caste heads are as long-suffering and as pliant as our bishops and archbishops, but they cannot be driven, and indiscriminate abuse of their customs and religion only stiffens their backs, and encourages a reaction.

The president of an important (Coconada) social conference said the other day "that the families who put the reform paper programme into practice were kept at arm's length even by the reform associations, that there has been no progress in twenty-five years, that among the members of reform associations will not be found men of light and leading, that the reformers have been playing with reform, that many are losing their faith in reform, and are inclined to retrace their steps." The fact is none of them were willing to admit that caste would allow them to talk, but not to act.

The Abbé Dubois "believed caste to be the happiest effort of Hindu legislation, solely owing to which India did not lapse into a state of barbarism, and owing to which she preserved and perfected arts and sciences while other nations remained in a state of barbarism." This eminent missionary, in 1816, and Sir John Strachey, in 1899, alike urged that between caste, customs, and religion, no line can be drawn, and the former, with the wisdom of the serpent, pointed out that caste, which confines its professors to sectarian, local, and restricted interests, makes national life and national action impossible. He also allows the Hindus to be kind, over-indulgent parents and their women chaste, exacting and obtaining the fullest respect. Indeed, as regards their property and the custody of their children, I am not sure that Hindu women have not greater rights at law than our women at the present day. Sanskrit moral stanzas are full of saws on woman's side, while those in which women are decried are no more numerous and not so severe as what we read in Greek, Latin, and British literature. They say: "Three persons are always well received, a brave soldier, a learned scholar, and a pretty woman."

Even Sir Monier Williams, a scholar of books, who looked on modern Indian practice as a disgrace to ancient Indian ideals, said: "It is most surprising that unhappy marriages are rare in India." He had the fact there, and his want of experience of the people supplied the surprise. He also got at the truth when he mentioned that "Hindu husbands do not beat their wives, and that women's influence over men is as great as their influence in Europe."

I have seen it suggested in graphic and interesting tales purporting to be a picture of Indian life that for Brahmin widows to remarry is no extraordinary occurrence.

That earnest, but temperate reformer, Mr. Dutt, one of the most English of Bengalis, though in the "Lake of Palms," he describes by the mouth of one of his characters the marriage of a Hindu widow from the Hindu standpoint "as a sin, public scandal, a madness beyond thought, an act against which the Hindu world would turn, as an outrage worse than a crime," yet represents a pious family as sanctioning such a marriage by the advice of a holy man, who pointed out that the "scriptures," if the Vedas correspond with the scriptures, "sanction remarriage." How far reforming zeal impairs the power of perspective will be obvious, when we learn in one page that "social boycotting has lost its horrors in India," and in another that "women of good birth and family dared not ask the married widow to their feasts and ceremonies."

The characters portrayed in this valuable and interesting book could never look without disgust upon such advertisements as occasionally appear in the Indian press: "Wanted, a young virgin widow, to be married to a bachelor of 24, with high prospects; fair, and good looking; object being reformation; full particulars and personal interview after approval of photo; proper party only need apply." This hardly satisfies Hindu standards of modesty, though hard by in Burma "Ma Thet hereby informs the public that Maung Po Min' is no longer my husband, has no claim to my property, and I will not be responsible for debts contracted by the said Maung Po Min'."

As to the misery of Indian widows, the reforming Indian press has fastened upon Sister Nivedita's (Miss Noble) statement that "the Protestant missionaries have misunderstood the matter, and that the widow is not regarded with aversion and contempt; that her position is the result of intensity of moral development, and not of its lack." This is I think, a strong presentment of the case, but violent and unreasonable condemnation is the rule.

Sir Richard Temple wrote of Upper India: "Enforced widowhood is not nearly so general as is made out by those who would deduce a moral from Indian manners for the glorification of the habit of the Christians."

Take the figures for Hindustan proper, the North-West or United Provinces. Of the Hindu population 24 per cent prohibit, and 76 per cent permit and encourage remarriage of widows, and in all but the very highest castes every young widow finds a mate. Nearly a century ago, the Abbé Dubois, in ante-reform days, said: "Young widows bear their fate much better than might be expected. They are, perforce, resigned, and however despised a widow may be, one who remarries is a hundred times more so; shunned by every honest and respectable person, there are few widows who would not look on a proposal of remarriage as a downright insult. Nor is the resulting immorality as great as might be expected, owing to the chaste and circumspect demeanor of Hindu women." Mr. Beauchamp, the learned editor of Dubois, on this remarks, in 1897: "Those few who brave caste and remarry are invariably outcasted." Sir Madhava Rao pointed out how much less important this question is than is often represented, and showed that a very small proportion of prohibited widows, who are themselves a very small proportion, would, if permitted, remarry.

There are, however, steps the people can take to improve their marriage customs, and girls under ten are already less frequently married; but the late Sir Madhava Rao, an advanced thinker and one of the reform party, thought there was as much to deprecate as to imitate in our own system. He considered the life of a Hindu girl as happy as that of a bird or bee, and by no means wanting in the knowledge needed for her life, and he thought as well of Hindu women, as others do who know them.

I cannot do better than end by quoting again my old friend, who was one of the most distinguished Hindus of his generation, and a minister in two great native States. He said: "Many writers on Hindu social reform have not clearly understood the existing system, which is the product of long development, nor accurately compared it with other systems, before underrating the advantages and exaggerating the disadvantages of the Indian system. The great majority of the people who retain their religious beliefs and social usages, would prefer non-representation to misrepresentation by those who have given up those beliefs and usages."—Journal of the Society of Arts.

ELECTRICITY AND THE FOOD PROBLEM.

ELECTRICITY would appear to have something in common with the forces of plant life and it is just possible that some day the world's food supply will be furnished by its means. Already we know that when intense electrical discharges occur in air nitric acid is produced which, when neutralized with soda, potash, or lime, furnishes the indispensable nitrate for plant life. At the present moment the Falls of Niagara are being utilized in this way. But apparently electricity is capable of producing food substances in a much more direct way than this. Given carbon, hydrogen, and oxygen in the simple association existing in carbonic acid gas and water, the current under certain conditions will bring about, according to recent researches, a rearrangement of the elements until at length carbohydrates are obtained. It is stated that by merely passing a current of definite potential through soda water or water impregnated with carbonic acid gas a series of products is formed culminating in sugars. First of all is formed oxalic acid, then tartaric acid, next citric acid, until at five volts and three amperes grape sugar appears. If these things are true, no more wonderful or astonishing discovery could be imagined. Carbonic acid gas and water are abundant enough throughout the whole world and to convert these simple substances into complex foodstuffs, for the supply of which we have to look to far countries, by simply manipulating them with the electric current,

surely promises to bring about one of the greatest revolutions in the history of the world.

But we have to reckon with nitrogen, the essential element of the proteid or flesh-forming portions of all food. As its Greek derivation implies (*τα πρωτεια* pre-eminence), proteid is a vital constituent of all food, and it has been said "without proteid we die." Is it possible, then, that proteid will eventually be built up by electrical means in the same way as is carbohydrate? In such case plant life will no longer be indispensable to man. Though at present proteid cannot be constructed directly, yet the production of nitrate by electricity is a source of stimulus to the synthesizing process of the plant and therefore electricity comes again to our aid in the production of food. As to the mineral salts of food, they again are essential; but, then, of course, chemistry has long since furnished us with material for their production. It seems clear that the chemist and physicist are unfolding Nature's ways with a rapidity which is startling considering that what they have already achieved amounts to saying that given an abundant supply of chalk, air, and water the food problem is solved. The ingredients of the formula are in truth plentiful enough, but what a dismal world when plant life is no longer necessary to the human race.—The Lancet.

THE TETRAHEDRAL PRINCIPLE IN KITE STRUCTURE.*

By ALEXANDER GRAHAM BELL, President of the National Geographic Society.

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IN 1899, at the April meeting, I made a communication to the Academy upon the subject of "Kites with Radial Wings;" and some of the illustrations shown to the Academy at that time were afterward published in the Monthly Weather Review.†

Since then I have been continuously at work upon experiments relating to kites. Why, I do not know,

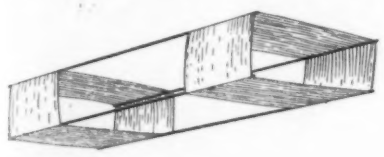


FIG. 1—HARGRAVE BOX KITE

FIG. 2

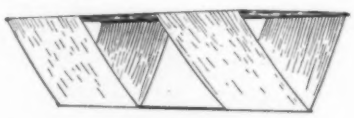


FIG. 3

excepting perhaps because of the intimate connection of the subject with the flying-machine problem.

We are all of us interested in aerial locomotion; and I am sure that no one who has observed with attention the flight of birds can doubt for one moment the possibility of aerial flight by bodies specifically heavier than the air. In the words of an old writer, "We cannot consider as impossible that which has already been accomplished."

I have had the feeling that a properly constructed flying-machine should be capable of being flown as a kite; and, conversely, that a properly constructed kite should be capable of use as a flying-machine when driven by its own propellers. I am not so sure, however, of the truth of the former proposition as I am of the latter.

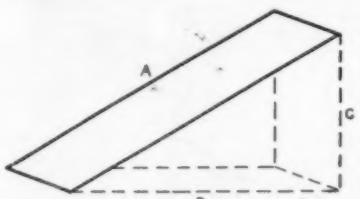


FIG. 4

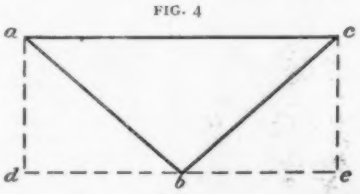


FIG. 5

Given a kite, so shaped as to be suitable for the body of a flying-machine, and so efficient that it will fly well in a good breeze (say 20 miles an hour) when loaded with a weight equivalent to that of a man and engine; then it seems to me that this same kite, provided with an actual engine and man in place of the load, and driven by its own propellers at the rate of 20 miles an hour, should be sustained in calm air as a flying-machine. So far as the pressure of the air is concerned, it is surely immaterial whether the air moves against the kite, or the kite against the air.

Of course in other respects the two cases are not identical. A kite sustained by a 20-mile breeze possesses no momentum, or rather its momentum is equal to zero, because it is stationary in the air and has no motion proper of its own; but the momentum of a heavy body propelled at 20 miles an hour through still air is very considerable. Momentum certainly aids flight, and it may even be a source of support against gravity quite independently of the pressure of the air. It is perfectly possible, therefore, that an apparatus may prove to be efficient as a flying-machine which cannot be flown as a kite on account of the absence of *vis viva*.

However this may be, the applicability of kite experiments to the flying-machine problem has for a long time past been the guiding thought in my researches.

I have not cared to ascertain how high a kite may be flown or to make one fly at any very great altitude. The point I have had specially in mind is this: That the equilibrium of the structure in the air should be perfect; that the kite should fly steadily, and not move about from side to side or dive suddenly when struck by a squall, and that when released it should drop slowly and gently to the ground without material oscillation. I have also considered it important that the framework should possess great strength with little weight.

I believe that in the form of structure now attained the properties of strength, lightness, and steady flight have been united in a remarkable degree.

In my younger days the word "kite" suggested a structure of wood in the form of a cross covered with paper forming a diamond-shaped surface longer one way than the other, and provided with a long tail composed of a string with numerous pieces of paper tied at intervals upon it. Such a kite is simply a toy. In Europe and America, where kites of this type prevailed, kite-flying was pursued only as an amusement for children, and the improvement of the form of structure was hardly considered a suitable subject of thought for a scientific man.

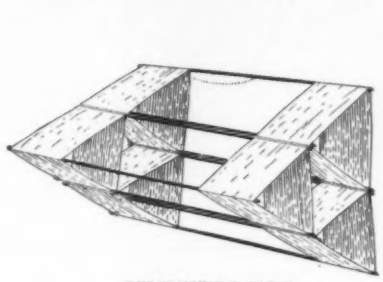
In Asia kite-flying has been for centuries the amusement of adults, and the Chinese, Japanese, and Malays have developed tailless kites very much superior to any form of kite known to us until quite recently.

It is only within the last few years that improvements in kite structure have been seriously considered, and the recent developments in the art have been largely due to the efforts of one man—Mr. Laurence Hargrave, of Australia.

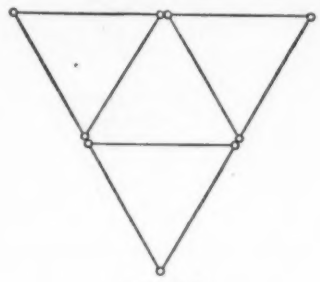
Hargrave realized that the structure best adapted for what is called a "good kite" would also be suitable as the basis for the structure of a flying-machine. His researches, published by the Royal Society of New South Wales, have attracted the attention of the world, and form the starting point for modern researches upon the subject in Europe and America.

Anything relating to aerial locomotion has an interest to very many minds, and scientific kite-flying has everywhere been stimulated by Hargrave's experiments.

In America, however, the chief stimulus to scientific kite-flying has been the fact developed by the United States Weather Bureau, that important information could be obtained concerning weather conditions if kites could be constructed capable of lifting meteorological instruments to a great elevation in the free air. Mr. Eddy and others in America have taken the Malay tailless kite as a basis for their experiments, but Prof. Marvin, of the United States Weather Bureau; Mr. Rotch, of the Blue Hill Observatory, and many others have adapted Hargrave's box kite for the purpose.



PERSPECTIVE VIEW



END VIEW

FIG. 6—COMPOUND TRIANGULAR KITE

Congress has made appropriations to the Weather Bureau in aid of its kite experiments, and a number of meteorological stations throughout the United States were established a few years ago equipped with the Marvin kite.

Continuous meteorological observations at a great elevation have been made at the Blue Hill Observatory in Massachusetts, and Mr. Rotch has demonstrated the possibility of towing kites at sea by means of steam vessels so as to secure a continuous line of observations all the way across the Atlantic.

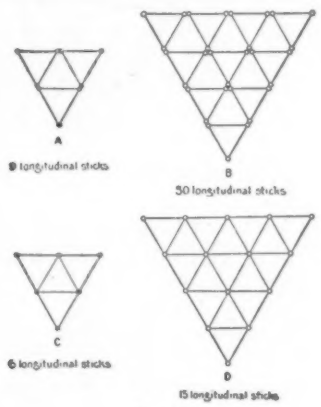


FIG. 7

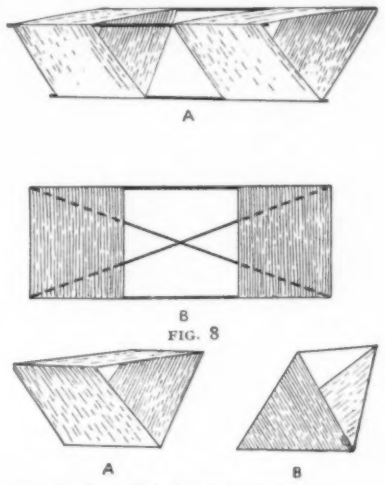


FIG. 8

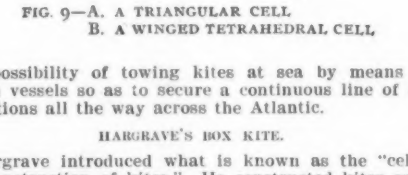


FIG. 9—A. A TRIANGULAR CELL
B. A WINGED TETRAHEDRAL CELL

HARGRAVE'S BOX KITE.

Hargrave introduced what is known as the "cellular construction of kites." He constructed kites composed of many cells, but found no substantial improvement in many cells over two alone; and a kite composed of two rectangular cells separated by a considerable space is now universally known as "the Hargrave box kite." This represents, in my opinion, the high-water mark of progress in the nineteenth century; and this form of kite forms the starting point for my own researches (Fig. 1).

The front and rear cells are connected together by a framework, so that a considerable space is left between them. This space is an essential feature of the kite; upon it depends the fore and aft stability of the kite. The greater the space, the more stable is the equilibrium of the kite in a fore and aft direction, the more it tends to assume a horizontal position in the air, and the less it tends to dive or pitch like a vessel in a rough sea. Pitching motions or oscillations are almost entirely suppressed when the space between the cells is large.

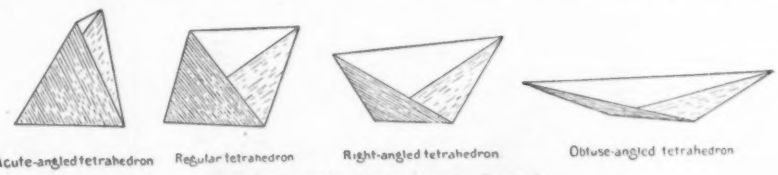


FIG. 10—WINGED TETRAHEDRAL CELLS

Each cell is provided with vertical sides; and these again seem to be essential elements of the kite contributing to lateral stability. The greater the extent of the vertical sides, the greater is the stability in the lateral direction, and the less tendency has the kite to roll, or move from side to side, or turn over in the air.

In the foregoing drawing I have shown only necessary details of construction, with just sufficient framework to hold the cells together.

It is obvious that a kite constructed as shown in Fig. 1 is a very flimsy affair. It requires additions to the framework of various sorts to give it sufficient

* A communication made to the National Academy of Sciences in Washington, D. C. April 28, 1903, revised for publication in the National Geographic Magazine.

† See Monthly Weather Review, April, 1899, vol. xxvii, pp. 154-155, and plate xi.

strength to hold the aeroplane surfaces in their proper relative positions and prevent distortion, or bending or twisting of the kite frame under the action of the wind.

Unfortunately the additions required to give rigidity to the framework all detract from the efficiency of the kite: First, by rendering the kite heavier, so that the ratio of weight to surface is increased; and, secondly, by increasing the head resistance of the kite. The interior bracing advisable in order to preserve the cells from distortion comes in the way of the wind, thus adding to the *drift* of the kite without contributing to the *lift*.

FIG. 11—ONE-CELLED TETRAHEDRAL FRAME

FIG. 12—FOUR-CELLED TETRAHEDRAL FRAME

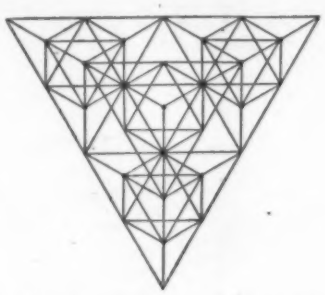


FIG. 13—SIXTEEN-CELLED TETRAHEDRAL FRAME

A rectangular cell like *A* (Fig. 2) is structurally weak, as can readily be demonstrated by the little force required to distort it into the form shown at *B*. In order to remedy this weakness, internal bracing is advisable of the character shown at *C*.

This internal bracing, even if made of the finest wire, so as to be insignificant in weight, all comes in the way of the wind, increasing the head resistance without counterbalancing advantages.

TRIANGULAR CELLS IN KITE CONSTRUCTION.

In looking back over the line of experiments in my own laboratory, I recognize that the adoption of a triangular cell was a step in advance, constituting indeed one of the milestones of progress, one of the points that stand out clearly against the hazy background of multitudinous details.

Fig. 3 is a drawing of a typical triangular-celled kite made upon the same general model as the Hargrave box kite shown in Fig. 1.

A triangle is by its very structure perfectly braced in its own plane, and in a triangular-celled kite like that shown in Fig. 3, internal bracing of any character is unnecessary to prevent distortion of a kind analogous to that referred to above in the case of the Hargrave rectangular cell (Fig. 2).

The lifting power of such a triangular cell is probably less than that of a rectangular cell, but the enormous gain in structural strength, together with the reduction of head resistance and weight due to the omission of internal bracing, counterbalances any possible deficiency in this respect.

The horizontal surfaces of a kite are those that resist descent under the influence of gravity, and the vertical surfaces prevent it from turning over in the air. Oblique aeroplanes may therefore conveniently be resolved into horizontal and vertical equivalents, that is, into supporting surfaces and steadying surfaces.

The oblique aeroplane *A*, for example (Fig. 4), may be considered as equivalent in function to the two aeroplanes *B* and *C*. The material composing the aeroplane *A*, however, *weighs less* than the material required to form the two aeroplanes *B* and *C*, and the framework required to support the aeroplane *A* weighs less than the two frameworks required to support *B* and *C*.

In the triangular cell shown in Fig. 5, the oblique surfaces *ab*, *bc*, are equivalent in function to the three surfaces *ad*, *de*, *ec*, but weigh less. The oblique surfaces are therefore advantageous.

The only disadvantage in the whole arrangement is that the air has not as free access to the upper aeroplane *ac*, in the triangular form of cell as in the quadrangular form, so that the aeroplane *ac* is not as efficient in the former construction as in the latter.

While theoretically the triangular cell is inferior in lifting power to Hargrave's four-sided rectangular cell, practically there is no substantial difference. So far as I can judge from observation in the field, kites constructed on the same general model as the Hargrave box kite, but with triangular cells instead of quadrangular, seem to fly as well as the ordinary Hargrave form, and at as high an angle.

Such kites are therefore superior, for they fly substantially as well, while at the same time they are stronger in construction, lighter in weight, and offer less head resistance to the wind.

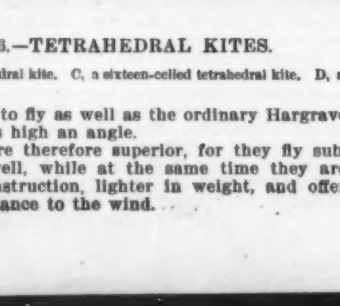


FIG. 14—FOUR-CELLED TETRAHEDRAL KITE

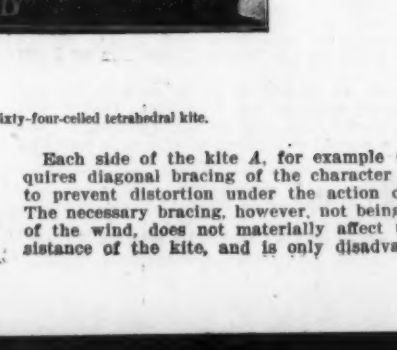


FIG. 15—SIXTEEN-CELLED TETRAHEDRAL KITE

Triangular cells also are admirably adapted for combination into a compound structure, in which the aeroplane surfaces do not interfere with one another. For example, three triangular-celled kites, tied together at the corners, form a compound cellular kite (Fig. 9) which flies perfectly well.

The weight of the compound kite is the sum of the weights of the three kites of which it is composed, and the total aeroplane surface is the sum of the surfaces of the three kites. The ratio of weight to surface therefore is the same in the larger compound kite as in the smaller constituent kites, considered individually.

It is obvious that in compound kites of this character the doubling of the longitudinal sticks where the corners of adjoining kites come together is an unnecessary feature of the combination, for it is easy to construct the compound kite so that one longitudinal stick shall be substituted for the duplicated sticks.

For example: The compound kites *A* and *B* (Fig. 7) may be constructed, as shown at *C* and *D*, with advantage, for the weight of the compound kite is thus reduced without loss of structural strength. In this case the weight of the compound kite is *less* than the sum of the weights of the component kites, while the surface remains the same.

If kites could only be successfully compounded in this way indefinitely we would have the curious result that the ratio of weight to surface would diminish with each increase in the size of the compound kite. Unfortunately, however, the conditions of stable flight demand a considerable space between the front and rear sets of cells (see Fig. 6); and if we increase the diameter of our compound structure without increasing the length of this space we injure the flying qualities of our kite. But every increase of this space in the fore and aft direction involves a corresponding increase in the length of the empty framework required to span it, thus adding dead load to the kite and increasing the ratio of weight to surface.

While kites with triangular cells are strong in a transverse direction (from side to side), they are structurally weak in the longitudinal direction (fore and aft), for in this direction the kite frames are rectangular.

Each side of the kite *A*, for example (Fig. 8), requires diagonal bracing of the character shown at *B* to prevent distortion under the action of the wind. The necessary bracing, however, not being in the way of the wind, does not materially affect the head resistance of the kite, and is only disadvantageous by

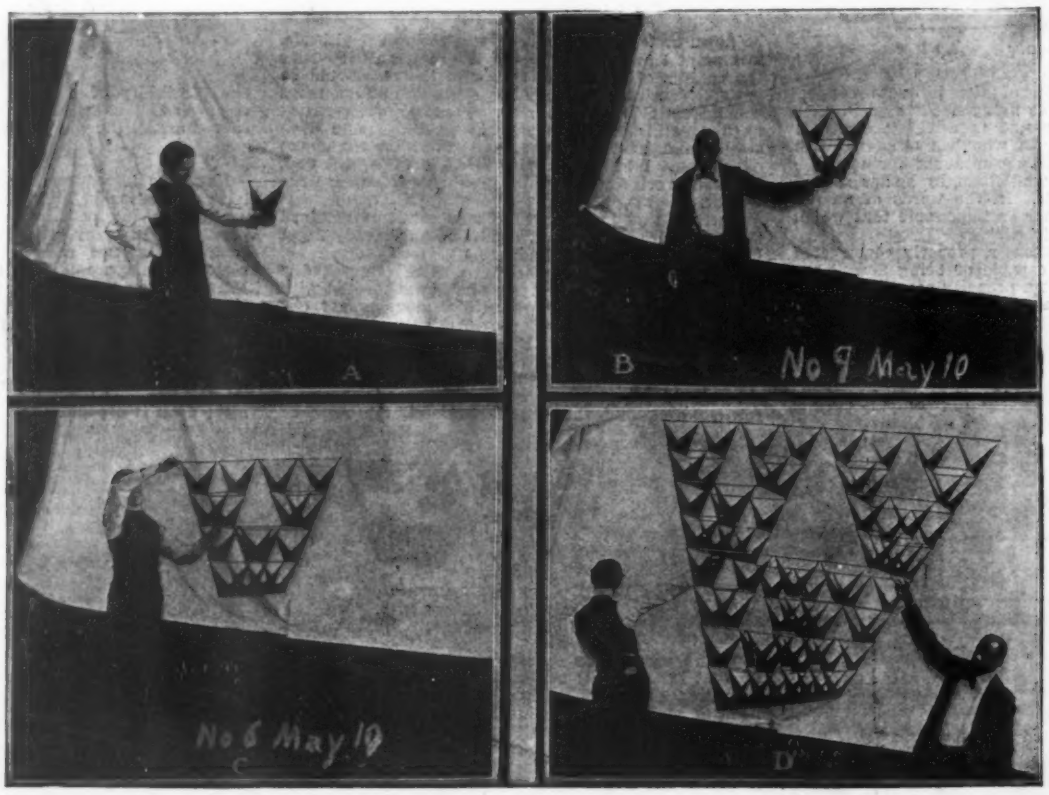


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FIG. 16.—TETRAHEDRAL KITES.

A, a winged tetrahedral cell. B, a four-celled tetrahedral kite. C, a sixteen-celled tetrahedral kite. D, a sixty-four-celled tetrahedral kite.

adding dead load, thus increasing the ratio of weight to surface.

THE TETRAHEDRAL CONSTRUCTION OF KITES.

Passing over in silence multitudinous experiments in kite construction carried on in my Nova Scotia laboratory, I come to another conspicuous point of advance—another milestone of progress—the adoption of the triangular construction *in every direction* (longitudinally as well as transversely); and the clear realization of the fundamental importance of the skeleton of a tetrahedron, especially the regular tetrahedron, as an element of the structure or framework of a kite or flying-machine.

Consider the case of an ordinary triangular cell *A* (Fig. 9) whose cross-section is triangular laterally, but quadrangular longitudinally.

If now we make the longitudinal as well as transverse cross-sections triangular, we arrive at the form of cell shown at *B*, in which the framework forms the outline of a tetrahedron. In this case the aeroplanes are triangular, and the whole arrangement is strongly suggestive of a pair of bird's wings raised at an angle and connected together tip to tip by a cross-bar (see *B*, Fig. 9; also drawings of winged tetrahedral cells in Fig. 10).

A tetrahedron is a form of solid bounded by four triangular surfaces.

In the regular tetrahedron the boundaries consist of four equilateral triangles and six equal edges. In the skeleton form the edges alone are represented, and the skeleton of a regular tetrahedron is produced by joining together six equal rods end to end so as to form four equilateral triangles.

Most of us no doubt are familiar with the common puzzle—how to make four triangles with six matches. Give six matches to a friend and ask him to arrange them so as to form four complete equilateral triangles. The difficulty lies in the unconscious assumption of the experimenter that the four triangles should all be in the same plane. The moment he realizes that they need not be in the same plane the solution of the problem becomes easy. Place three matches on the table so as to form a triangle, and stand the other three up over this like the three legs of a tripod stand. The matches then form the skeleton of a regular tetrahedron. (See Fig. 11.)

A framework formed upon this model of six equal rods fastened together at the ends constitutes a tetrahedral cell possessing the qualities of strength and lightness in an extraordinary degree.

It is not simply braced in two directions in space like a triangle, but in three directions like a solid. If I may coin a word, it possesses "*three-dimensional*" strength; not "two-dimensional" strength like a triangle, or "one-dimensional" strength like a rod. It is the skeleton of a solid, not of a surface or a line.

It is astonishing how solid such a framework appears even when composed of very light and fragile material; and compound structures formed by fastening these tetrahedral frames together at the corners so as to form the skeleton of a regular tetrahedron on a larger scale possess equal solidity.

Fig. 12 shows a structure composed of four frames like Fig. 11, and Fig. 13 a structure of four frames like Fig. 12.

When a tetrahedral frame is provided with aero-surfaces of silk or other material suitably arranged, it becomes a tetrahedral kite, or kite having the form of a tetrahedron.

The kite shown in Fig. 14 is composed of four winged cells of the regular tetrahedron variety (see Fig. 10), connected together at the corners. Four kites like Fig. 14 are combined in Fig. 15, and four kites like Fig. 15 in Fig. 16 (at *D*).

Upon this mode of construction an empty space of octahedral form is left in the middle of the kite, which seems to have the same function as the space between the two cells of the Hargrave box kite. The tetrahedral kites that have the largest central spaces preserve their equilibrium best in the air.

The most convenient place for the attachment of the flying cord is the extreme point of the bow. If the cord is attached to points successively further back on the keel, the flying cord makes a greater and greater angle with the horizon, and the kite flies more nearly overhead; but it is not advisable to carry the point of attachment as far back as the middle of the keel. A good place for high flights is a point half-way between the bow and the middle of the keel.

In the tetrahedral kites shown in the plate (Fig. 16) the compound structure has itself in each case the form of the regular tetrahedron, and there is no reason why this principle of combination should not be applied indefinitely so as to form still greater combinations.

The weight relatively to the wing-surface remains the same, however large the compound kite may be.

The four-celled kite *B*, for example, weighs four times as much as one cell and has four times as much wing-surface, the 16-celled kite *C* has sixteen times as much weight and sixteen times as much wing-surface, and the 64-celled kite *D* has sixty-four times as much weight and sixty-four times as much wing surface. The ratio of weight to surface, therefore, is the same for the larger kites as for the smaller.

This, at first sight, appears to be somewhat inconsistent with certain mathematical conclusions announced by Prof. Simon Newcomb in an article entitled "Is the Air-Ship Coming?" published in McClure's Magazine for September, 1901—conclusions which led him to believe that "the construction of an aerial vehicle which could carry even a single man from place to place at pleasure requires the discovery of some new metal or some new force."

The process of reasoning by which Prof. Newcomb arrived at this remarkable result is undoubtedly correct. His conclusion, however, is open to question, because he has drawn a general conclusion from restricted premises. He says:

"Let us make two flying-machines, exactly alike, only make one on double the scale of the other in all its dimensions. We all know that the volume, and therefore the weight, of two similar bodies are proportional to the cubes of their dimensions. The cube of two is eight; hence the large machine will have eight times the weight of the other. But surfaces are as the squares of the dimensions. The square of two is four. The heavier machine will therefore expose only four times the wing surface to the air, and so will have a distinct disadvantage in the ratio of efficiency to weight."

Prof. Newcomb shows that where two flying machines—or kites, for that matter—are exactly alike, only differing in the scale of their dimensions, the ratio of weight to supporting surface is greater in the larger than the smaller, increasing with each increase of dimensions. From which he concludes that if we make our structure large enough it will be too heavy to fly.

This is certainly true, so far as it goes, and it accounts for my failure to make a giant kite that should lift a man—upon the model of the Hargrave box kite. When the kite was constructed with two cells, each about the size of a small room, it was found that it would take a hurricane to raise it into the air. The kite proved to be not only incompetent to carry a load equivalent to the weight of a man, but it could not even raise *itself* in an ordinary breeze in which smaller kites upon the same model flew perfectly well. I have no doubt that other investigators also have fallen into the error of supposing that large structures would necessarily be capable of flight, because exact models of them, made upon a smaller scale, have demonstrated their ability to sustain themselves in the air. Prof. Newcomb has certainly conferred a benefit upon investigators by so clearly pointing out the fallacious nature of this assumption.

But Prof. Newcomb's results are probably only true when restricted to his premises. For models *exactly alike, only differing in the scale of their dimensions*, his conclusions are undoubtedly sound; but where large kites are formed by the multiplication of smaller kites into a cellular structure the results are very different. My own experiments with compound kites composed of triangular cells connected corner to corner have amply demonstrated the fact that the dimensions of such a kite may be increased to a very considerable extent without materially increasing the ratio of weight to supporting surface; and upon the tetrahedral plan (Fig. 16) the weight relatively to the wing-surface remains the same however large the compound kite may be.

The indefinite expansion of the triangular construction is limited by the fact that dead weight in the form of empty framework is necessary in the central space between the sets of cells (see Fig. 6), so that the necessary increase of this space when the dimensions of the compound kite are materially increased—in order to preserve the stability of the kite in the air—adds still more dead weight to the larger structures. Upon the tetrahedral plan illustrated in Figs. 14, 15, 16, no necessity exists for empty frameworks in the central spaces, for the mode of construction gives solidity without it.

Tetrahedral kites combine in a marked degree the qualities of strength, lightness, and steady flight; but further experiments are required before deciding that this form is the best for a kite, or that winged cells without horizontal aeroplanes constitute the best arrangement of aero-surfaces.

The tetrahedral principle enables us to construct out of light materials solid frameworks of almost any desired form, and the resulting structures are admi-

FIG. 18.—THE AERODROME KITE JUST RISING INTO THE AIR WHEN PULLED BY A HORSE.

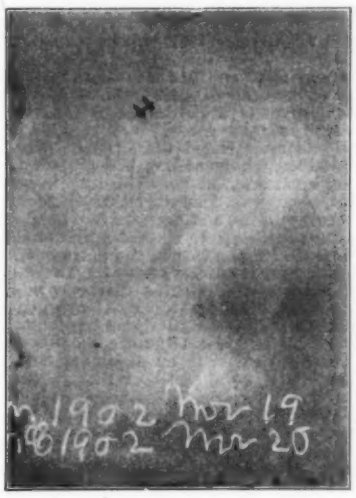

FIG. 19.—AERODROME KITE IN THE AIR.

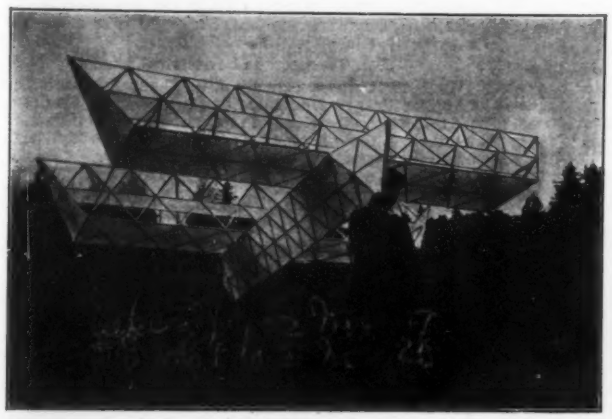

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FIG. 17.—THE AERODROME KITE.

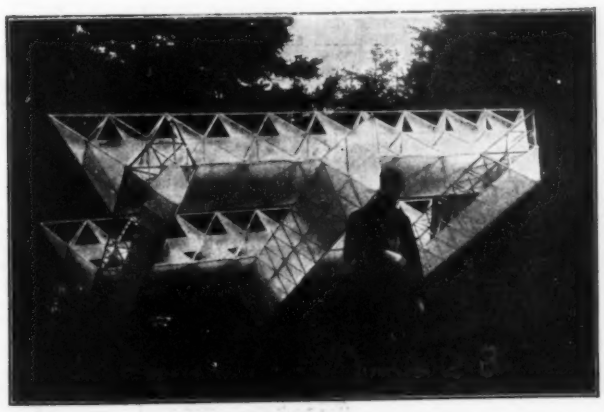

FIG. 20.—FLOATING KITE.

rably adapted for the support of aero-surfaces of any desired kind, size, or shape (aeroplanes or aerocurves, etc., large or small).

In further illustration of the tetrahedral principle as applied to kite construction, I show in Fig. 17 a photograph of a kite which is not itself tetrahedral in form, but the framework of which is built up of tetrahedral cells.

This kite, although very different in construction and appearance from the aerodrome of Prof. Langley, which I saw in successful flight over the Potomac a few years ago, has yet a suggestiveness of the aerodrome about it, and it was indeed Prof. Langley's apparatus that led me to the conception of this form.

The wing surfaces consist of horizontal aeroplanes, with oblique steadying surfaces at the extremities. The body of the machine has the form of a boat, and the superstructure forming the support for the aeroplanes extends across the boat on either side at two points near the bow and stern. The aeroplane surfaces form substantially two pairs of wings, arranged dragon-fly fashion.

The whole framework for the boat and wings is formed of tetrahedral cells having the form of the regular tetrahedron, with the exception of the diagonal bracing at the bottom of the superstructure; and the kite turns out to be strong, light, and a steady flyer.

I have flown this kite in a calm by attaching the cord—in this case a Manila rope—to a galloping horse. Fig. 18 shows a photograph of the kite just rising into the air, with the horse in the foreground, but the connecting rope does not show. Fig. 19 is a photograph of the kite at its point of greatest elevation, but the horse does not appear in the picture. Upon releasing the rope the kite descended so gently that no damage was done to the apparatus by contact with the ground.

Fig. 20 shows a modified form of the same kite, in which, in addition to the central boat, there were two side floats, thus adapting the whole structure to float upon water without upsetting.

An attempt which almost ended disastrously, was made to fly this kite in a good sailing breeze, but a squall struck it before it was let go. The kite went up, lifting the two men who held it off their feet. Of course they let go instantly, and the kite rose steadily in the air until the flying cord (a Manila rope ⅜ inch diameter) made an angle with the horizon of about 45 deg. when the rope snapped under the strain.

Tremendous oscillations of a pitching character ensued; but the kite was at such an elevation when the accident happened, that the oscillations had time to die down before the kite reached the ground, when it landed safely upon even keel in an adjoining field and was found to be quite uninjured by its rough experience.

Kites of this type have a much greater lifting power than one would at first sight suppose. The natural assumption is that the winged superstructure alone supports the kite in the air, and that the boat body and floats represent mere dead-load and head resistance. But this is far from being the case. Boat-shaped bodies having a V-shaped cross-section are themselves capable of flight and expose considerable surface to the wind. I have successfully flown a boat of this kind as a kite without any superstructure whatever, and although it did not fly well, it certainly supported itself in the air, thus demonstrating the fact that the boat surface is an element of support in compound structures like those shown in Figs. 17 and 20.

Of course the use of a tetrahedral cell is not limited to the construction of a framework for kites and flying-machines. It is applicable to any kind of structure whatever in which it is desirable to combine the qualities of strength and lightness. Just as we can build houses of all kinds out of bricks, so we can build structures of all sorts out of tetrahedral frames, and the structures can be so formed as to possess the same qualities of strength and lightness which are characteristic of the individual cells. I have already built a house, a framework for a giant wind-break, three or four boats, as well as several forms of kites, out of these elements.

It is not my object in this communication to describe the experiments that have been made in my Nova Scotia laboratory, but simply to bring to your attention the importance of the tetrahedral principle in kite construction.

[Dr. Bell's article is followed by an appendix of over seventy illustrations of kites and structures used by Dr. Bell.—ED.]

[Continued from SUPPLEMENT No. 1431, page 22927.]

ON ELECTRONS.*

By SIR OLIVER LODGE, F.R.S., Vice-President.

PART V.

DETERMINATION OF THE MASS OF AN ELECTRON.

So far, all the measurements quoted have resulted in a consensus of certainty respecting our knowledge of e/m for gaseous conduction and radiation; and the measurements made on the cathode rays in a Crookes tube, or near a plate leaking in ultra-violet light, have likewise given us a knowledge of their velocity, and shown that it is about one-thirtieth of the velocity of light, more or less, according to circumstances. But so far no direct estimate has been made of either e or m separately. The difficulty of making these measurements is great, because we are dealing with an aggregate of an enormous and unknown number of these bodies. It would not be difficult to make a determination of the aggregate mass of a set of projectiles, say $N m$, where N is the number falling on a target in a given time, by means of the heat which the blow generates; or better, perhaps, by the momentum which they would impart to a moving arm after the fashion of a ballistic pendulum, provided their velocity, u, were known, as in this case it is. The aggregate energy, $\frac{1}{2} N m u^2$, or the aggregate momentum, $N m u$, could thus be found; but how is m to be separated from N?

Again, if the particles are collected in a hollow vessel attached to an electrometer of known capacity, it is not difficult to estimate the total quantity of electricity which enters the vessel in a given time, that is to say, to determine $N e$; but, again, how are we to discriminate e from N?

We may consider the following quantities experimentally determined, by researches carried on at the Cavendish laboratory and elsewhere and so far already described or indicated:

$$e/m$$
$$u$$
$$N_0 e$$
$$N m$$

See *ante*, Part III., for measurements of these quantities for the case of cathode rays.*

Another thing that is comparatively easy to determine, especially in such cases as leak from a negative surface under the action of ultra-violet light, or the conductivity of air induced by the impact of Röntgen rays, is the total current transmitted, viz., the quantity $N e u$ the quantity of electricity conveyed per second. Measurements of this quantity have been made not only by Lenard† and Righi‡ and Thomson,§ but in various gases by Rutherford,‖ now professor at Montreal; by Beattie¶ and de Smolan at Glasgow, by Zeleny,** of Minnesota, by McClelland†† on hot gases from flames, and by McLennan,‡‡ of Toronto.

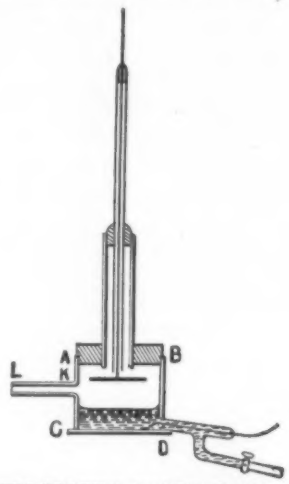

FIG. 4.—THIS FIGURE CORRESPONDS CLOSELY WITH FIG. 2, PART III, ONLY THAT A LAYER OF WATER REPLACES THE WIRE GAUZE. THE VESSEL WAS ATTACHED TO THE EXPANSION APPARATUS FIG. 3.

Prof. Zeleny in particular measured the velocity by a safe and direct method of making the particles fly against a wind down a tube, and observing the rate of the current of air which was just able to withstand their progress, these measurements constituting a satisfactory confirmation of Thomson's and Rutherford's more indirectly inferred results.

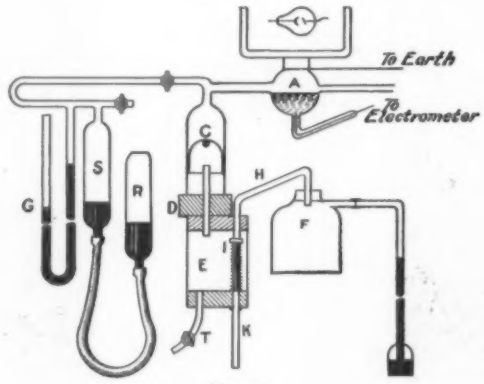

FIG. 3.

A is the vessel in which the fog is formed whose rate of fall is to be measured by Mr. Wilson's method as used by him for the ionization produced by X-rays. The vessel *A*, containing some water, is in communication with a vessel *C* through the tube *B*. Inside *C* is a thin walled test-tube *P*, which serves as a piston. *D* is an India-rubber stopper closing the end of tube *C*. A glass tube connects the inside of the test-tube *P* with a space *E*. This space may be put in connection with an exhausted space *F* through the tube *H*. The end of the tube *H*, inside the space *E*, is ground flat, and is closed by an India-rubber stopper *I*, which is kept pressed against the tube *H* by means of a spiral spring. The stopper *I* is fixed to a rod *K*; by pulling the rod down smartly the pressure inside the test-tube is lowered, and the piston *P* falls rapidly until it strikes against the India-rubber stopper *D*. The falling of the piston causes the gas in *A* to expand; the tubes *R* and *S* are for the purpose of regulating the initial pressure. Before an expansion the piston *P* is raised by a trifling amount of air introduced through T, and the clip *S* is closed. Then, when everything is ready, *K* is pulled, and the cloud forms in *A*.

If only it were now possible to *count* the corpuscles or electrons, to determine the number N which are started into existence, or which enter the hollow vessel, or which take part in conveying the current in the case of a leak by ultra-violet light, we should no longer have to *guess* at the actual value of e and of m separately, but should have really *determined* them.

This brilliant research has actually been carried out by Prof. J. J. Thomson, by means of a method partly due to Mr. C. T. R. Wilson, supplementing a fact discovered by Mr. Aitken, and interpreted in the light of a hydrodynamic theorem arrived at long ago by Sir George Stokes.

I must be excused for waxing somewhat enthusiastic over this matter; it seems to me one of the most brilliant things that has recently been done in experimental physics. Indeed I should not take much urging to cancel the "recently" from this sentence; save that it is never safe for a contemporary to usurp the function of a future historian of science, who can regard matters from a proper perspective.

The matter is rather long to explain from the beginning, and I must take it in sections.

Aitken and Cloud Nuclei.

First of all, Mr. John Aitken, of Edinburgh, discovered in 1880 that cloud or mist globules could not form without solid nuclei, so that in perfectly clear and dust-free air aqueous vapor did not condense, and mist did not form.

Without solid surfaces, in clear space, vapors could become supersaturated; but the introduction of a nucleus would immediately start condensation, and according to the number of nuclei, or condensation centers, so will be the number of cloud globules formed.

Every cloud or mist globule is essentially a minute raindrop, not floating in the least, but falling through the air—falling slowly because it is of such insignificant weight and is moving in a resisting medium—but falling always relatively to the air. A cloud may readily be carried up by a current of air, but that is only because the air is moving up faster than the drops are trickling down through it. No motion of the air disturbs the relative falling motion; the absolute motion with reference to the earth's surface is the resultant of the two.

The fact that nuclei are required for mist precipitation can be proved by filtering them out with cotton wool, and finding that as the nuclei get fewer the mist condensation differs in character becoming ultimately what is called a Scotch mist, such as forms in fairly clean air; where since the dust particles are comparatively few, the centers of condensation are few also, and accordingly each has to condense a considerable amount, so that the drops are bigger, and not nearly so close together; wherefore they fall quicker like very fine rain. In perfectly clean elaborately-filtered air the dew point may be passed without any vapor condensing, and the space will remain quite transparent in spite of its being supersaturated with vapor.

The reason for this effect of, and necessity for, nuclei, is well known in the light of Lord Kelvin's theory concerning the effect of curvature on surface tension, because the more a liquid surface is curved the more it tends to evaporate, and an indefinitely convex surface would immediately flash off into vapor. Consequently an infinitesimal globule of liquid cannot exist; vapor can only condense on a surface of finite curvature, such as is afforded by a dust particle or other body consisting of a large aggregate of atoms. For it must be remembered that a single grain of lycopodium powder contains about a trillion atoms, and a dust particle big enough to condense vapor need not consist of more than a billion, or perhaps not more than a million, atoms, and need by no means be big enough to be visible. It is, however, material enough to be stopped by a properly packed cotton-wool filter.

J. J. Thomson and Electrical Nuclei.

In 1888 it was shown by J. J. Thomson, in his book "Applications of Dynamics to Physics and Chemistry," p. 164, that electrification of a body would partially neutralize the effect of curvature, and so assist the condensation of vapor on a convex surface.

Consider a drop of liquid, or a soap-bubble; the effect of the convexity of the surface is to give a radial component of surface tension inward, causing an increased pressure internally. The effect of electrification is just the opposite; it causes a direct pressure outward, which goes by the name of the electric tension.

They are differently affected by the size of the globule; hence at some size or other they must balance, and such an electrified convex surface will behave as if it were unelectrified but flat. Accordingly vapor which would refuse to condense on an ordinary convex surface, until far below the dew point, will begin to condense on it, if sufficiently electrified, the instant the dew point is reached.

The critical size at which the ionic charge enables a sphere of water to act, as regards condensation, as if it were flat, can be reckoned by equating the pressure to the tension.

This is proved to be of atomic magnitude, so that ions can condense vapor; and anything smaller which possesses the same charge can condense it still more easily.

In moist air, therefore, it would appear (parenthetically) as if electrons could hardly exist isolated, but must be associated with at least an atomic mass of matter.

Accordingly an electric charge assists vapor to condense; and a sufficient electric charge might cause it to condense on quite a small body—as small even as an atom, or smaller. Hence in the presence of electrified ions or electrons, dust particles are not necessary for condensation. Vapor may condense on these electrical nuclei without the need for solids of finite curvature. The electrical nuclei cannot be filtered out by cotton wool; they will exist or can be produced in dust-free air. No doubt if they are passed through a great amount of metal gauze they may be diminished in number, but they are not easy to get rid of except by their own diffusion, which does ultimately enable them to pair off or to migrate to the sides of the vessel. They can be got rid of, most easily, however, by electrolyzing the air, that is to say, by supplying electrodes maintained at a few volts difference of potential. They will then immediately make a procession, as in electrolysis, only with much greater speed, because their motion is much less resisted or interfered with by chance collisions; so they will soon reach and cling to their respective electrodes, and in that case again no true mist can form.

While ions or electrons are present in considerable

* Excerpt from a paper read before the Institution of Electrical Engineers and published in the Journal of Proceedings of the Institution.

* J. J. Thomson, Phil. Mag., October, 1897.
† Wied. Ann., vol. 63, p. 253.
‡ Rend. della R. Accad. dei Lincei, May, 1896.
§ Phil. Mag., November, 1896.
‖ Ibid., November, 1896, and April, 1897.
¶ Ibid., June, 1897.
** Ibid., July, 1898.
†† Ibid., July, 1898.
‡‡ Phil. Trans., vol. 195, p. 49, 1899.

numbers a thick mist will form whenever the space is saturated with vapor, but it will be a mist of different appearance from the slight rain-like condensation which may be seen forming round the few residual dust particles. The mist globules will usually be of uniform size, and some estimate of that size can be roughly attempted by the diffraction colors which can be seen if a point of light is looked at through the mist; not, however, a very easy plan of making a trustworthy estimate.

Electrical nuclei can be produced in various ways—by anything, in fact, which dissociates the air or which fills it with ions. Some are produced by the splashing and spray of water; some are given off from flames, and from red-hot bodies; they are produced in considerable numbers when Röntgen rays travel through air; they can be given off by radio-active substances like uranium; and they are easily emitted by a negatively-charged metallic surface exposed to ultra-violet light.

Wilson and Metrical Cloud Condensation.

Mr. C. T. R. Wilson, in his study at the Cavendish Laboratory of cloud formation under the influence of Röntgen rays and by other methods, devised a plan for precipitating a definite and known quantity of aqueous vapor in a visible form. This was done by an arrangement for making a sudden or adiabatic expansion of saturated air, and making it to a carefully measured amount. The apparatus employed is shown in Fig. 3.

One test-tube moving inside another is employed as a pistor, and by a certain arrangement the piston was enabled to drop with great suddenness and thus to produce a measured small exhaustion in the reservoir containing the gas under experiment, saturated as it is with vapor, and supplied with electric nuclei. The mist at once formed, and the drops began to fall slowly, as usual. Mr. Wilson tried to get an estimate of their size from the colors, but it was difficult and unsatisfactory. If the size had been known, their number would have been known, too, because the measured amount of expansion had produced a known fall of temperature below the dew point, and so had condensed a known amount of aqueous vapor, which would be distributed equally among all the equal globules.

It occurred to J. J. Thomson that a better estimate of size could be made by observing their rate of falling, which is a thing not difficult to observe since they all fall together, being all of the same size. In any mist formed in a bell-jar it is easy to watch it settling down, by watching its fairly definite upper surface, a clear space being left above it which gradually increases in thickness as the cloud falls. The rate of movement of the top of the cloud will give the rate of falling of the individual globules of which it is composed. And this brings us to the next section.

Prof. Stokes and Falling Spheres.

Many years ago, in 1849, Sir George G. Stokes* discussed the motion of solids through fluids, and among others of a sphere moving through a viscous fluid urged by its own weight. It is a familiar fact that large bodies fall through air or water or any resisting medium more quickly than small ones of the same shape. Thus, coarse sand settles down through water quicker than fine sand, and the finest powder takes a very long time to settle; in fact this difference of the rate of falling is used as a practical process of separating granular materials into sizes, and is called levigation.

So it is in air; large raindrops fall violently, small raindrops fall gently, and mist globules hardly fall at all—fall so slowly that their motion is difficult to observe; but the same law governs all so long as the motion is not too violent, or so long as the falling body has no edges such as will cause eddies during the fall. A sphere falling slowly, controlled by viscosity alone without waves or eddies, is the simplest case. It soon reaches what is called a terminal velocity—the speed at which the viscous resistance exactly balances its weight. At this speed it is subject to zero resultant force, so it simply obeys the first law of motion and moves at a constant speed,† which was calculated by Sir George Stokes, and a simple formula was obtained giving the connection between the rate of fall of a raindrop and its size. By observation of this speed, therefore, knowing the viscosity of air, it is possible to calculate the dimensions of the falling drops.

J. J. Thomson's Experiment of Counting.

We have now all the materials ready for understanding the experiment to be performed,‡ so as to count the ions which are produced in air under the impact of Röntgen rays, or when there are electrons to be counted which have been produced from a negatively electrified surface illuminated with ultra-violet light. The apparatus for the latter is depicted in Fig. 4. A clean zinc surface in vacuo, faced by a piece of wire gauze through which the light could shine on it, and by a window of quartz which makes the vessel air tight, so that it might be exhausted and yet allow the ultra violet light to pass, was employed as shown in Fig. 2 *ante;* the present arrangement is similar except that a water surface replaces the gauze.

The rate of leak which gives the current $N e u$ is determined by connecting the water and the zinc plate to the terminals of an electrometer, the zinc plate being kept negative by means of a battery of a sufficient number of cells.

And now, supplying this apparatus with the adiabatic expansion appliances of C. T. R. Wilson shown in Fig. 3 above, metrical condensation can be produced, a mist will form, and the rate of its fall can be observed; whence by Stokes's theorem the size of each globule is known; the quantity of water which had gone to form globules is known from the measured amount of expansion, by a process the details of which I will not give here; and so the number of such globules, and therefore the number of their condensation-centers or nuclei or ions, can be determined.

The number of drops found in a certain experiment by this means was about 30,000 to the cubic centimeter, the total quantity of water which went to form them being about the two-hundredth part of a milligramme.

Result.

The result of the execution of this ingenious counting process is that the absolute charge and the absolute mass of an electron are at length directly determined.

The electric charge comes out, as suspected, in all cases, the regular ionic charge, of the order of magnitude 3×10^{-10} electrostatic, or 10^{-20} electromagnetic units; hence m comes out for positive carriers and for ions the appropriate mass of the atoms present. In some cases the masses are greater than this and represent molecular aggregates. But for the negative carriers set free by ultra-violet light, and for the other cases where $e/m = 10^7$, the masses come out definitely of the order 10^{-27} gramme; or about 1-700 part of the smallest and lightest previously known quantity of matter, viz., an atom of hydrogen.

The existence of masses smaller than atoms was thus experimentally demonstrated, and a discovery was clinched of epoch-making importance.

(To be continued.)

THE MYSTERY OF RADIO-ACTIVITY.

SINCE Becquerel discovered that uranium and its compounds gave off continuously some form of radiation capable of making an impression on a photographic plate, and deviable by a magnetic field, a great deal of attention has been devoted by physicists to the study of the radio-activity of matter, and new and much more intensely radio-active substances have been discovered. It has been shown that temporary radio-activity can be communicated to bodies in which the property is not inherent, and that this excited radio-activity is very widely spread in nature, a circumstance which may yet lead to the explanation of many of the hitherto inexplicable phenomena of atmospheric electricity.

The explanation of radio-active phenomena is intimately connected with the new electron theory. At first, indeed, it was supposed that the Becquerel rays were simply a spontaneous discharge of negative electrons from the radio-active substance, and, consequently, that they were identical with cathode rays. But further investigation has shown that their composition is by no means so simple as this hypothesis would imply. Cathode rays consist of a stream of negatively charged particles, or electrons, of very much smaller mass than the smallest atom, and the cathode rays as this theory would lead us to expect, are easily deflected by a transverse magnetic field. Now it has been found that only a part of the radiation from uranium is deviable by a magnetic field, so we are forced to the conclusion that there is something more in these rays than a stream of negative electrons.

The presence of cathode rays among the Becquerel rays would lead us to predict that Röntgen rays would be found to be a constituent of the non-deviable rays emitted by radio-active bodies. The usual method of producing Röntgen rays is by the impact of cathode rays upon the matter of the anti-cathode. The electrons discharged by the radio-active bodies are not likely to get clear without a considerable amount of collision with the atoms through which they pass to the surface. These collisions would give rise to Röntgen rays. Now Röntgen rays are characterized by their non-deviability in the magnetic field, and by their great penetrating power, and Sir William Crookes, in a paper read before the Royal Society on March 19, has, by means of these characteristics, demonstrated their presence in the radiation from radium, the most powerful of all known radio-active substances. When a platinum wire dipped in nitrate of radium was brought near a platino-cyanide of barium screen, scintillations or splashes of light were observed when the screen was examined by a microscope. Sir William Crookes attributes these scintillations to the impact of electrons discharged from the radium. There was also on the screen a general luminosity which undoubtedly was due to Röntgen rays, because when mica or aluminium foil was interposed the scintillations were arrested, but the general luminosity on the screen was not affected.

It remains to be considered whether there is any other constituent present in Becquerel rays, in addition to cathode rays and Röntgen rays. Of the presence of one other constituent, undoubted proof has been given by Mr. E. Rutherford and others. The following is Rutherford's analysis of the radiation emitted by radium (Phil. Mag., vol. v., p. 177, February, 1903); (α) rays (non-deviable) with a penetrating power represented by .0005 cm. of aluminium; (β) rays (deviable) with penetrating power equal to .05 cm. of aluminium; (γ) rays (non-deviable) with penetrating power equal to 8 cm. of aluminium. The (β) rays are cathode rays, and the (γ) rays are Röntgen rays, but what are the (α) rays? Though the (α) rays are not deviable with magnetic fields of moderate strength, Rutherford has succeeded with a very powerful magnetic field in effecting a measurable deviation. The deviation, however, is in the opposite direction to the deviation of the (β) rays, showing that the electric charge of the particles in the (α) rays must be positive. The small amount of the deviation of the (α) rays also points to the conclusion that their mass is much greater than the mass of the particles in the (β) rays. The ratio of their mass m, to their electric charge e, has been calculated by Rutherford as being approximately $\frac{m}{e} = \frac{1}{6 \times 10^3}$. Now $\frac{m}{e}$ for the hydrogen atom is about $\frac{1}{10^4}$, but for the electron it is about $\frac{1}{10^7}$. Everything, therefore, points to the conclusion that the (α) rays consist of a stream of atoms with a positive electric charge. This may be termed the positive ion, as it corresponds to the part of the molecule which travels toward the cathode in electrolysis, or it may be termed the positive electron, as it corresponds to the positive atom which combines with a negative electron to form a neutral or nearly neutral combination. The larger size of the particles in the (α) rays gives a satisfactory explanation of their low penetrating power. They cannot pass through between the atoms, even of a gas, without a much greater chance of collision than the relatively much smaller negative electrons.

One of the most remarkable properties of Becquerel rays, a property which they share with cathode rays and Röntgen rays, is the power of dissociating or ionizing the molecules of a gas and thereby increasing its conductivity. It is by means of this property that the exact quantitative analysis of Becquerel radiation has been carried out. The strength of the radiation is measured by the number of molecules which it dissociates, and as an electric current is only possible where the elements of a dissociated molecule are present to act as carriers, the number of the dissociated elements can be very exactly measured by a sensitive electric current meter. The most suitable instrument has been found to be the quadrant electrometer, and the current is measured by noting the speed at which the needle moves as the instrument is charged. Rutherford considers that, in the case of the Becquerel rays, by far the greatest part of the ionization of the surrounding gas is effected by the (α) rays, i. e., by the positively charged atoms, positive electrons, or whatever they may be called. The (α) rays appear to be identical with the *Canal Strahlen* of Goldstein.

This analysis of the Becquerel radiation into three distinct kinds of rays which can be identified with forms of radiation already known, does not, however, bring us to the end of the mystery of radio-activity. Rutherford (Phil. Mag., 1900, pp. 1 and 161) discovered that in addition to a straight line radiation, compounds of thorium gave off an emanation which behaved like a neutral gas, but was itself radio-active, and had the power of exciting temporary radio-activity in all surrounding bodies with which it came in contact. This emanation could be passed through white hot tubes, bubbled through acids, or filtered through cotton wool without losing any of its remarkable properties. Curie showed, shortly after, that radium gave out a similar emanation. Polonium and uranium, however, give out no emanation. If one of the bodies surrounding the emanation has a negative electric charge, the whole of the excited radio-activity will be confined to its surface. This experiment suggests that the emanation may consist of positive ions or electrons. This hypothesis, however, is upset by the fact that the emanation of radium persists for weeks, though exposed to a strong electric field. The emanation appears to act by withdrawing negative electrons from the molecules of air, and thus leaving positive oxygen electrons which are drawn by the electric field on to the negatively-electrified surface. A layer of positive electrons on a surface attracts and projects negative electrons from beneath the charged surface, and thus excites a radio-activity consisting of (β) rays.

Elster and Geitel have shown that if a wire is maintained at a high negative potential for several hours, it becomes temporarily radio-active. Here again the attraction of the negative charge on the wire has led to the formation of a coating on the wire of positive electrons attracted from the surrounding atmosphere. Now, it has long been known that the earth has a strong negative charge of electricity, and we should consequently expect to find that the surface of the earth is radio-active, and also that the radio-activity would be strongest where the negative potential gradient is steepest—i. e., over projections and points on the earth's surface. Experiment has already demonstrated the truth of this surmise. In mountainous regions the radio-activity has been found to be greater than in the plains; the points of lightning rods and leaves of trees have also been found to be strongly radio-active. Since radio-activity means dissociation and increased conductivity of the air, the important bearing of this discovery on the phenomena of atmospheric electricity is evident.

Whatever the emanation may be, it behaves like a gas whose atoms have no chemical affinity and no electric charge. Rutherford considers that it may be a gas of the argon family, and from its rate of diffusion he has estimated that the atomic weight of the radium emanation lies somewhere between 40 and 100. Now, the atomic weight of radium has been estimated by Curie as 225, and from this we must infer that the emanation must be of an entirely different material from the radium from which it emanates.

There is every reason for believing that radio-active substances have been discharging positive and negative electrons and Röntgen rays into space for ages, and there is no sign of any diminution in the amount of energy which they give out. Physicists, imbued with the doctrine of the conservation of energy, have tried in vain to discover where the radio-active furnace gets its constant supply of fuel. It was long supposed that the quantity of energy given out was so minute that even if the supply of intrinsic energy in the molecules was small, no change would be perceptible except after the lapse of long intervals of time. But some recent experiments by MM. Curie and Laborde (Comptes Rendus, March 16, 1903) have shown that the amount of energy given out by a gramme of radium amounts to as much as 100 gramme-calories per hour. This would be equivalent to raising a 100-pound weight through a height of 3 feet per hour, and a gramme atom of radium would develop per hour as much heat as a gramme atom of hydrogen in combining with oxygen. It is hardly conceivable that a constant supply of energy of such magnitude could be kept up without taking in fresh energy from the outside.

Sir William Crookes accounts for the supply of energy by supposing that the radium atom has the power of absorbing the energy of the more rapidly moving particles of the atmosphere, and thus gets over the difficulty by endowing the radio-active atoms with the superhuman powers of Maxwell's "demons." Rutherford thinks the energy is derived from the shrinkage of the atom, much as the energy of volcanic eruptions is derived from the shrinkage of the earth. This would imply a transmutation into some other

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* Camb. Trans. Phil. Soc. ix. 48.

† Cf. Nature, vol. 31, p. 266.

‡ Phil. Mag., December, 1898, and December, 1899.

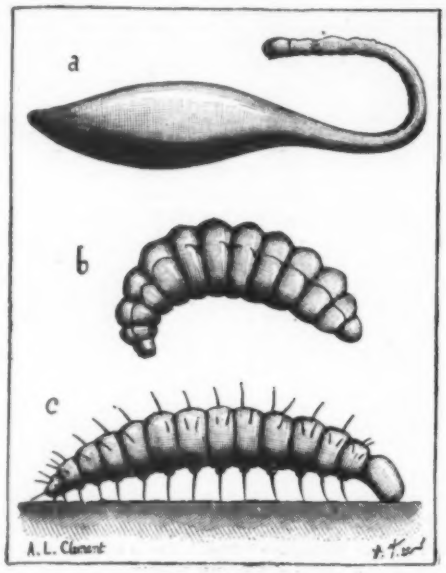
material, and Curie objects to this that the spectroscope has given no indication of such a change after an interval of several years. Curie himself thinks that radium utilizes an external energy of an unknown nature. Evidently we are yet a long way from a complete solution of the mystery of radio-activity.—The Electrical Review (London).

PARASITIC HYMENOPTERA.

NATURE is not perfect any more than is man. No group of animals shows this better than that of the Hymenoptera. The majority of these insects might serve as an emblem of labor and ingenuity. Always in motion, they exhibit a feverish activity in the construction of their nests and in storing up food. But, among them, there are a certain number that, doubtless through laziness or incompetence, have lost the habit of working and have became parasites. Such Hymenoptera do not differ from other and more enterprising species, and, if they desired to, might work as well as the latter. But they do not wish to.

One of the Hymenoptera that is most exploited by such parasites is one of the most industrious—the Chalicodoma, or mason bee, which erects for its young a castle of earth, a fortress that would seem to be a sure protection for them. Each cell crammed full of honey and pollen, is the objective point of several vagabonds, one of the most active of which is the Stelis, a puny insect that one would not think was made for leading the existence of a "housebreaker." Such is its life, nevertheless. After the Chalicodoma has finished its nest, the Stelis is seen promenading feverishly over the surface, exploring it with its antennæ, and doubtless seeking the weak point of the crust of sun-baked clay. After it has found the place of least resistance, it begins the work of perforating the clay of stone-like hardness. Although this is for it the labor of a Titan, it does not become discouraged, but removes the particles of earth atom by atom, digs a minute pit, comes to the covering of the nest and perforates that likewise, and, finally, reaches the provisions, the objects of its desires. Here, perhaps, it nibbles the paste a little in order to recruit itself; but this is not the real object of its entrance. What it especially desires, and what it hastens to do, moreover, is to deposit a certain number of eggs upon the honey. But, since it would not be prudent to leave the food exposed to the air and at the disposal of other parasites, the Stelis, after having been a miner, becomes a mason. Gathering some red clay in the vicinity, it kneads it with saliva and stops up the aperture previously formed. Then the female Stelis flies off to attend to other matters without any concern as to what will take place in the nest. In fact, she may well be at ease as to the future of her progeniture. The eggs of the Chalicodoma and those of the Stelis give birth to larvæ, which, living fraternally side by side, eat the honey upon which they rest. But the larvæ of the parasite, in addition to being more numerous, are more voracious, and quickly devour all the food and reach the end of their growth. The worm of the Chalicodoma, being more tardy in its development, is thus quickly deprived of food and dies of starvation. Without having the appearance of it, the operation of the female Stelis is therefore a true assassination.

The mason bee is exploited also by another Hymenopter, the Dioxys, which, like the Stelis, has a longing merely for the provisions amassed by the Chalicodoma, and it is only involuntarily and indirectly that either causes the death of its host. The Leucopsis, another parasite, has more depraved habits. Its larva devours the nymph of the mason bee by sucking it until it is reduced to its skin. This operation, although slow, is performed with such art that the victim does not become decomposed during the entire repast, which lasts for several days. The adult Leucopsis is a beautiful Hymenopter striped with black and yellow. For the deposition of its egg in the nest of the Chalicodoma, it is provided with a terebra .56 of an inch in length, folded in two and composed externally of a sheath divided in two, and internally of a round, stiff, horny bristle analogous to a horse-hair. This is the drill that is to pierce the dome of mortar. For this purpose, it is provided at the extremity with a sort of rasp with very blunt teeth and a beveled point. After she has reached maturity, the female Leucopsis explores the nests of the Chalicodoma and finally stops at one of them without it being possible to know what has guided her in her selection. She is then seen to stand erect on her legs, unsheath her terebra, and apply its point to the earth. Without any motion on the part of the insect, the drill begins to operate, and in less than a quarter of an hour this slender bristle will have perforated the covering of sun-baked clay



LEUCOPSIS.

a, egg (greatly magnified); b, secondary larva; c, primary larva.

in which it would have been difficult for the blade of a penknife to make an incision. An egg then slides through the terebra or depositor into the nest; but it is not to rest there alone for any length of time, since another Leucopsis reaches the nest, and, doubtless led by the same considerations that guided the first explorer, implants its terebra at the same point, and deposits an egg. Upon opening a Chalicodoma's nest, it is not rare to find therein four or five eggs of the Leucopsis attached by their curved beaks to the cocoon of the mason bee; and what is a curious thing is that when we open a nest, after the hatching of the eggs of the Leucopsis, we never find but a single larva of the latter. What has taken place in the interval? Simply this: The first larva hatched out has eaten the other eggs in order to be alone at the table, so to speak. In order to facilitate this fratricide, nature has provided each of the rings of the larva with a hyaline bristle carried by a conical papilla, and upon which it rests and is capable of moving about in order to devour the other occupants of the nest. This crime committed, the larva discards its traveling mantle and becomes transformed into a second larva deprived of means of locomotion, and which immediately begins to suck the unfortunate nymph of the mason bee. The "larval dimorphism" of the Leucopsis is therefore easily explained by its habits and by the insufficiency of the instinct of the adult, the terebra of which, leaving no trace of its entrance, does not sufficiently indicate to the new comers that the nest already contains an egg of their species.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.

THE MURAL CHALICODOMA AND ITS PARASITES.

AN OLD PELICAN MYTH EXPLODED.

MOST persons have seen a pelican, and many have heard of the strange legend attaching to it, says the London Globe. It is an odd looking creature, and if a figure of it were presented as a presumptive reconstruction of an extinct form, we might easily class it with other curiosities of antediluvian life. According to rabbinical tradition, the pelican was the third bird to come out of Noah's ark, and he still lives and thrives, perhaps as ancient a type among birds as the badger is supposed to be among quadrupeds. But his natural history is quite simple; while the legend is all the more interesting, inasmuch as it still obtained some credit in the last century. Thus it runs: "The pelican turneth her beak against her breast, and therewith pierces it till the blood gusheth out, wherewith she nourisheth her young." Though its origin is obvious, the tradition is of quite unknown age, but Waterton, the naturalist, had a traveled friend who devoutly believed in it, "because he had so often seen the incident occur." To whom Waterton addressed the allocution: "Enough of infant pelicans, sucking their mamma in the nursery. I consign them to the fostering care of my great-grandmother."

And yet, in common fairness, the matter may not be thus rudely dismissed. Of course, the ancients—with more excuse than can be urged for their descendants—were deceived, but they only intended to report fairly what they had seen and heard. The tradition, in fact, explains itself. The distinctive features of the pelican are its enormous bill, with the commensurate gular pouch depending from the lower mandible. So great is the capacity of this elastic receptacle and so considerable its strength, that the natives of many countries to this day convert it into a very useful bag. The upper mandible terminates in a hook, which curves over the tip of the lower, and is of a reddish color. During the breeding season the adult bird also acquires a red horny excrescence on the upper bill which it sheds later in the year. The tint of the feathers is fairly described by the poet as "pearly white, but ruby tinctured."

These facts being premised, we may assume that the two or three eggs laid by the mother have been successfully hatched. Then the parents begin to realize that in their case, at all events, "the cares of paternity" is no empty phrase. The amount of food consumed by the young is sometimes prodigious. As pelicans derive the whole of their sustenance from the water and feed almost exclusively on fish, the use, as the need, of their formidable fishing implements is apparent. Whether wading or swimming, they dredge and scoop their prey into the pouch, where it passes through some amount of maceration before being given to the young. And now ensues that curious act to which the observers of so many ages have given a wrong interpretation.

In order to eject the contents of the pouch, the bird presses its bill strongly and with a kind of spasmodic action against its breast, and the pinkish hue of its feathers, the red tipped bill, and often enough of the blood of its captured victims, combined to produce the effect which gave birth to the legend:

"The pelican his blod did biede,
Therwith his birddes for to feed."

This tradition seems to have found a tender foster mother throughout Christendom, and the proverbial "pelican in her piety" took root both as a symbol and a phrase. It should be remembered that the Romans regarded filial love as "piety," and it is, of course, in that sense that the word was understood. By degrees the figure of the pelican feeding her young developed into a common emblem of charity, the use of which especially prevailed in southern Europe. Many of the old Venetian trade guilds placed it on their banners, as a token that they were at all times ready to give their blood for their country. Almost as a matter of course the same figure became a frequent subject of decorative treatment in the mediæval church. More than one cardinal adopted it in his armorial bearings, and we find Henry VIII. changing the three cranes, which were a part of Archbishop Cranmer's arms, into three pelicans, for the reason that "these birds should signify to him that he ought to be ready, as the pelican is, to shed his blood for his young ones."

This, however, was by no means the first recognition of the fable in England, for the emblem of "the pelican in her piety" has been occasionally found carved on the wood or stonework of some of our ancient churches. But it seems to have had its chief stronghold in Spain, where the bird was for ages regarded with hardly less affection than reverence. Some years ago a considerable number were kept in the cloisters of the Cathedral at Barcelona, and it was a common practice for the people to visit them every Sunday, in the expectation of seeing the parent birds distribute their blood to their young. Aristotle makes no allusion to this reputed habit of the pelican, and Pliny appears to have confounded it with the spoonbill, a bird of quite a different family. And yet the legend was certainly in existence before the time of either, and it has naturally not come down to us without some variations and additions. Substantially, however, it remains the same, though the Egyptians made the pelican the emblem of folly, because it was said to take small care of its eggs.

"Primitive tradition," says Frederick Schlegel, "clothed with the ornaments of poetry, is often much nearer the truth than a dull reason that draws its estimate of probability from mere vulgar analogies." This seems almost exactly to reflect the attitude of the mediæval mind in respect to the legend of the pelican. Its habitual reverence was adverse to the spirit of inquiry. It may seem strange that the presumed act of laceration of its own breast did not lead to an examination of the bird supposed to have performed it. But even this would have been explained away, and the belief was too strongly impressed to favor such an almost sacrilegious course. As a matter of fact, the legend had some steadfast upholders less than a century ago, though it required a more modern system of reasoning to account for it. But, like Waterton's friend, people will believe what they see, or think they see, "with their own eyes."

With its powerful and strongly hooked bill the pelican was at least able to perform the act attributed to it, and other concurring external signs that it had really done so were not wanting. It was a myth, but who will grudge it its long and oft renewed lease of existence? The "pelican in her piety" was at least an effective lesson to the Old World, and its moral might even do something for our own. And we need not hesitate to rate the innocent credulity of ancient days above the widespread loutish insensibility of the present, which dignifies the slaughter of every feathered wanderer with the wrongful name of "sport."

AN ELIZABETHAN ARMY.*

By LIEUT.-COL. R. M. HOLDEN, Secretary Royal United Service Institution.

THE wood-cut reproduced is one of the best illustrations in existence of an English army on the march in time of Queen Elizabeth. Some information in regard to an army of that period may perhaps interest members of the Institution. The original sketch appears in a rare work, "The Image of Ireland," which was written in 1578, and published in 1581 by one John Derrick, a follower of Sir Henry Sidney in his campaigns in Ireland.

Sir Henry Sidney, K.G., to whom the book is dedicated, was father of Sir Philip Sidney (author of the celebrated romance, "Arcadia"), and three times held the office of Lord-Deputy in Ireland; he was by far the ablest of the many able men who governed that country under Elizabeth. In those days a Lord-Deputy lived more like the general of an invading army in a hostile country than the civil governor of a peaceful and allied province; Sidney was continuously employed in either preventing or actively suppressing rebellion.

The long reign of Queen Elizabeth may, in one sense, be termed a peaceful one, but there was, nevertheless, a constant demand for troops either against the Scots, to put down repeated rebellion in Ireland, to assist the Huguenots or the "Hollanders," or to defend the kingdom against the threatened invasion of the Spaniards. At the commencement of the reign, such military forces as the country possessed were in any but a condition of efficiency, while the discipline was of the worst. There was no permanent armed force in the kingdom, and even the trained bands or militia were no longer instructed in the use of arms, because the gentlemen no longer set the example. Troops were raised anyhow for an emergency, and, when the danger seemed past, the Queen, with her ruling passion—parsimony—promptly disbanded them. There is no doubt that England was behind all Europe in military efficiency, and this at a time when she was menaced by foreign enemies on all sides, and in perpetual peril of internal disorder. When apprehension of a Spanish invasion was constant, during the latter part of her reign, Elizabeth became more or less attentive to her internal forces, but, on the whole, it may be truly said that no monarch before or since has ever treated her army with more constant neglect than Queen Bess. Her great effort was in 1588, when the whole force in the kingdom for resisting the Spanish invasion amounted to about 135,000 men, formed into three armies; one at Tilbury, under the Earl of Leycester; another to resist the landing of the enemy and act as occasion required; and a third, under Lord Hunsdon, for the defense of Her Majesty's person. The justices of the peace of each county had been ordered, in conjunction with special commissioners, to muster the whole male population over sixteen years of age at the expense of the shire; and to register the residence and occupation of each, and the kind of service suited to them, whether carpenters, smiths, and so forth. The men were to be sorted in bands, so that there might be in each band at least one hundred footmen, forty arquebusiers, and twenty archers. Great care was ordered to be taken in the selection of the officers. In addition to the company organization, the force of each county appears to have been divided into regiments, or bands of 500, commanded by a general captain, a term equivalent to colonel, who also mustered the horsemen, 700 of whom attended each regiment. The arrangements then made were of great interest and importance; they were studied and repeated by our ministers, who in the old French war had to provide against the threatened invasion of Napoleon. Had the enemy landed, it is doubtful what sort of a front our troops would have displayed against the veterans of Spain. Their spirit was, no doubt, good, but dishonesty was rife, and the muster-masters were corrupt. We know from Sir John Smythe, an old soldier of some repute, that the clothing and equipment was bad, and that the arms were in bad condition and out of date. The situation was, doubtless, rendered more difficult by the fact that the business of war was passing through transition, and the long bow and the bill, with their accompanying tactics, were becoming things of the past. Military training no longer consisted in friendly matches at the archery butts. The old familiar instructors were cast aside for leaders from foreign schools, men who swaggered about in plumed hats and velvet doublets, and extravagant hose, swearing strange oaths of mingled blasphemy taught by Spanish Catholics and Lutheran landsknechts. Shakespeare was no mean observer of military matters; and, though it may provoke a smile, in his pages the student must look for the best history of the Elizabethan soldier.

The army depicted in the illustration is one of those hastily brought together to quell one of the numerous rebellions in Ireland. The men were raised by the ordinary process of the times—the pressgangs, which were not over-scrupulous in their methods. On one occasion they took advantage of Easter Sunday to close all the church doors in London and take a thousand men from the various congregations. At other times the prison doors were opened and the gaols cleared, the sweepings of the nation being driven into the ranks.

The force, it will be observed, is preceded by an advance guard of five mounted men armed with lances or spears. In addition to the lance, which was from sixteen to eighteen feet in length, each trooper carried a sword, and a shield bearing the cross of St. George. The shield was slung on the back on the march, but in action was carried in front of the breast for protection. The trooper's uniform comprised a helmet or pot, tunic or cassock of broadcloth and top boots. With the first introduction of fire-arms, the men-at-arms, or heavy cavalry, assumed most massive armor to ward off the effects of the arquebuse and pistol balls, but gradually the pieces were discarded one by one as useless incumbrances. The cavalry in the illustration wear armor on the body, arms, and above the knees, but it will be seen that the horses, no longer in danger of wounds from arrows, were freed from their armor.

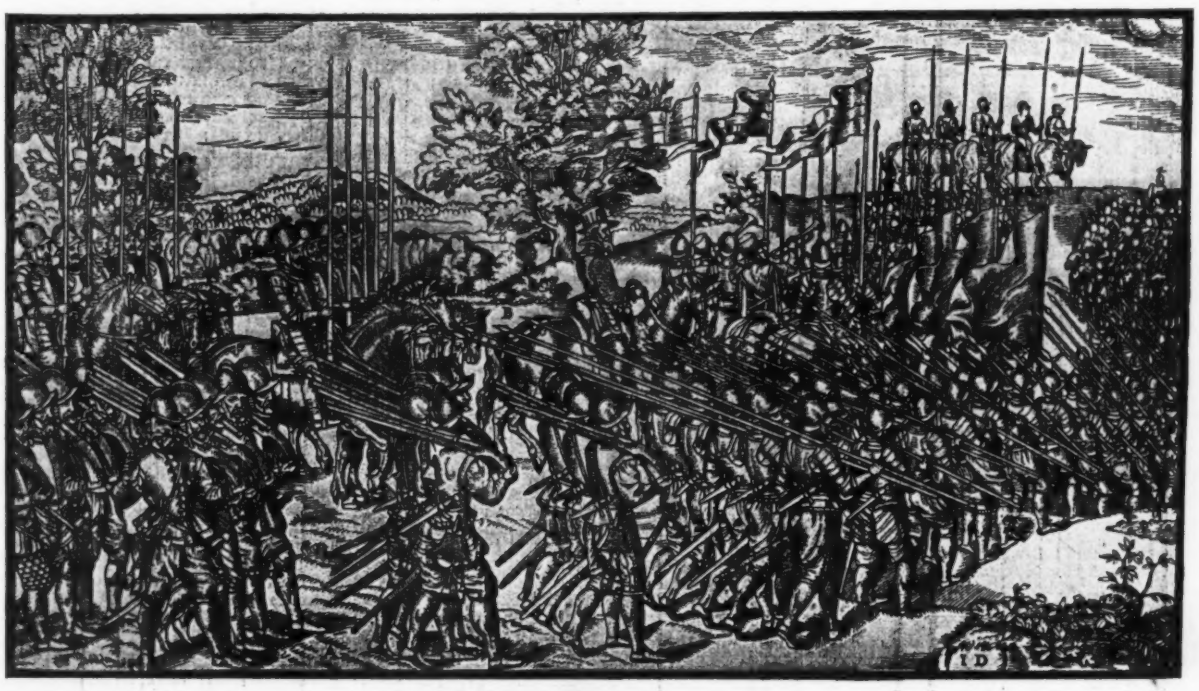
The infantry are headed by a party of arquebusiers, their arms consisting of arquebuse, sword, and dagger. They also carried powder-flask, touch-box, and bullet-bag. England was a long way behind foreign countries in the introduction of the arquebuse, and it was not until the year 1567, when the movements of Philip the Second gave the alarm of invasion, that we raised a corps of 4,000 arquebusiers.

Next to the arquebusiers march the pikemen, in their center being the flags, afterward called the colors, guarded by halberdiers. The pikemen wore helmet and armor for the body and arms, and carried sword and dagger, in addition to a pike made of ash and measuring some fifteen feet in length without the iron or steel head. Halberdiers were soldiers told off to escort general officers, or guard the colors. They carried halberts with battle-ax heads, but in other respects differed very little from pikemen. Following the pikemen come more arquebusiers carrying calivers or light arquebuses, and sword, dagger, powder-flask and bullet bag. The caliver was a lighter kind of matchlock, between a musket and an arquebuse. Arquebuses, like pikes, were sloped on the shoulder, but there does not appear to have been at that time any very serious attempt at a manual exercise; the men stepped off with the right foot.

The Lord-Deputy Sidney rides on the left flank of the army, preceded by trumpeters and standard, or guidon, bearers, and escorted by lancers, whose equipment has already been described. The music in an Elizabethan army was supplied by drums and fifes.

In her reign the army seems to have been clothed in various colors, according to the service on which it was employed. In 1566 the archers sent to Ireland from Liverpool were dressed in blue cassocks or coats, with two small gards or laces of blue. The Staffordshire men were in red; all the others in blue. Troops sent to Ireland the next year from Yorkshire wore light blue, with two small laces, red caps, and buckskin jerkins. In 1569, arquebusiers raised at Salisbury also wore blue coats and red caps. In 1574 the soldiers wore blue coats, the artificers red, and in 1575 the Earl of Essex's troops for Ireland wore blue coats and motley coats. Artificers sent from Lancashire to Ireland in 1576 wore white coats with red and green laces. Next year the billmen and pikemen for Ireland had light blue coats and white stockings and venetians or breeches. The lacing was red or yellow. But these bright hues were evidently found too conspicuous for active service in Ireland, for some dark or sad color, such as russet, was recommended in its stead—a curious anticipation of our modern khaki.

On parade each company stood ten deep; companies being usually one hundred strong were thus square, a point which was considered of great importance. Both ranks and files had three different distances: (1) open order (six feet apart); (2) order (distance with elbows up); (3) close order, used by the pikemen only. The evolutions were facing, wheeling, countermarching, and doubling their ranks and files; increasing either the depth or breadth of the corps, or changing the situation of the ranks and files with respect to front and rear, and right and left. The maneuvers of the times were forming wings, wedges, rhombs, squares, triangles, the shears, the saw, and a variety of other whimsical figures. The pikes formed the center, the musqueteers, who acted as skirmishers, the flanks of each corps. Such is the information given in the military treatises which were written after Elizabeth had introduced captains skilled in the maneuvers practised in the Low Countries, to drill her army. The highest military rank in an army appears to have been that of captain-general, after whom came the lieutenant-general, the judge or high marshal, afterward judge-advocate, and the generals of horse and foot. The duties of muster-master correspond to those of an adjutant.



AN ELIZABETHAN ARMY.

* Reprinted from the Journal Royal United Service Institution in the Journal of the Military Service Institution.

NEW FOOD FOR LIVE STOCK IN GERMANY.

DURING the past few years, experiments have been made in the city of Strassburg, Alsace, Germany, with a new food for horses and cattle, called "Blut-Kraftfutter" (blood-strength fodder), consisting of steam-dried, sterilized blood (prepared under the control of a municipal veterinary surgeon), chaff or the hulls of grain, finely ground, the husks of peanut kernels, and also the inner lining or skin of the peanut shells, and molasses. A per cent of phosphates is also added to the preparation.

These ingredients are thoroughly mixed and dried, and a certain portion of molasses (which has been heated to make it more liquid) is added. After this has been well mixed and dried, another portion of molasses is added, and after the final mixing and drying the preparation is ready for the market, and is sold in bags of 75 kilogrammes (165 pounds), at a cost of 11.50 marks ($2.75) per bag, retail.

The manager claimed that to use the whole peanut would make the preparation too expensive.

The manager of the Strassburg slaughterhouse, who is also manager of the blood-meal factory, says that the chaff (or "mais") is imported from America, and the molasses is purchased in Baden, being a product of the beet-sugar factories.

The dried blood meal, it is claimed, contains on an average 20 to 22 per cent of protein and fat, while

oats, according to the tabulated statement of Wolff, contain on an average only 15.2 per cent of protein and fat.

The assurance is given that this preparation can be preserved for any length of time, and that it will not deteriorate with age.

As regards the method of feeding, it is advisable—as horses and cattle are often very sensitive to a change of food—to start on one-half pound per day, thoroughly mixing it with the usual food, and to increase this portion daily until 5 or 6 pounds are used per day, diminishing the quantity of the usual food accordingly.

For milch cows, 3 pounds per day can be used; for fattening cattle, 7 pounds per head per day; and for sheep and swine, three-fourths of a pound per day per 100 pounds of living weight.

Some horses have been given two-thirds of their daily fodder in blood meal, but the company recommends that the quantity fed should not exceed one-half of the daily allowance of food.

In a circular which the company has issued are testimonials from owners of many horses, stating that they have experimented with this blood-meal preparation, and the result shows a saving of 31½ pfennigs (8 cents) per horse per day; also similar statements from milk dealers, who claim a gain of 40 pfennigs (10 cents) per cow per day in the saving of other foods and the increase of milk given through the use of this blood meal. It is said that the cattle appear remarkably well.

During the past year, the military authorities at Strassburg have been feeding this blood meal to the horses of the regiments stationed there, as an experiment, and the result seems to give satisfaction; and the manager of the factory believes that this preparation will soon be ordered to be fed to all army horses in the country, in which case the company will be confronted with the necessity of establishing factories in many of the large cities of northern Germany, where slaughterhouses are already located.

At the present time, the demand for this dried blood-meal preparation is far greater than the daily capacity of the factory, for the blood of 300 cattle—the average number slaughtered daily at the Strassburg slaughterhouse—is not sufficient.

EXPLORATIONS OF DR. SVEN HEDIN IN CENTRAL ASIA (1899-1902).

AMONG the latest explorations in Asia there is one which, by reason of its length, the difficulties surmounted, novelty of the routes chosen, and the results obtained deserves more than passing consideration. The exploration in question is that accomplished between 1899 and 1902 in Chinese Turkestan and in Thibet by Dr. Sven Hedin.

Leaving Sweden in the year 1899, Sven Hedin traversed Russia, Turkestan, then Tian-Chan, reached Kashgar and arrived at Laïlik on the Yarkand-daria, or Tarim, down the river from Yarkand. It was here the real work of exploration began.

Sven Hedin embarked on the 18th of September on the Yarkand-daria, of which he proposed to make a detailed study. Comfortably installed on a flat-boat and followed by another similar vessel carrying the provisions and supplies, he descended the river whose banks, covered by somber forests, served as lairs for tigers and wild-boars and recalled the jungles of India. He continued this navigation up to a point called Yangi-Koll, where, at the end of December, he was stopped by ice and where he met the French explorer Bonin.

This was the first time, that the Tarim, the large and curious river of Central Asia, which does not empty into the sea, was thus traversed. During all the time of his navigation, Dr. Sven Hedin took soundings and noted details. His chart of the river, on a scale of 1 to 35,000, covers a hundred sheets; it gives the changes of the current, the alluvial deposits, the accumulations of mud, the sand-banks, and the villages, tombs and shepherds' camps on the shores, the lagoons and lateral lakes.

Having measured the swiftness of the current and the fall of the river every day, Sven Hedin found that its volume of water undergoes great variations. The course of the Tarim is modified constantly and not a year passes during which the channel does not undergo a noticeable displacement generally toward the south.

During the winter 1899-1900, Dr. Sven Hedin, unable to continue the navigation of the Tarim, made his way toward the south by the Takla-Makane, the most desolate desert in the world, which he had previously faced during his first voyage. The part which he traversed, between the lower Tarim and Tiertien-daria, had never before been visited. Sleeping under the open sky in the dead of winter with the temperature 33 degrees C. below zero, and exposed to the greatest dangers, the explorer traversed in twenty days 285 kilometers of this limitless sea of sand where the furious winds have piled up dunes a hundred meters high. He returned to his camp at Yangi-Köll by a different route, purposing to accomplish his study of the lower Tarim.

Now the attention of the traveler was centered upon the mobile and variable lakes of the lower basin. On the 5th of March, 1900, Sven Hedin turned toward the desert of Lob following the dry bed of the Koom-daria, which formerly carried the waters of the Tarim to Lob-nor, a lake which has at this time disappeared. Its shores, formerly inhabited, have become desolate; and great was the astonishment of the traveler when he passed south of Altimish-Houlak, to find in the open desert ruins of houses and temples. The season being too unfavorable, he proposed to return a little later to study this locality and to explore it. He traversed the entirely waterless basin of the ancient Lob-nor, which is in reality nothing more than a dry lake-bed whitened with thousands of small shells, its former shores marked by a circle of dead trees. He descended thence to Kara-Koshoon, a lake which to-day turns aside the Tarim; then he returned to Yangi-Köll.

The Tarim therefore is a movable river. This phenomenon is especially noticeable as one leaves Yangi-Köll; the lateral lakes appear more numerous and on the right side there is visible a whole string spreading from the N. N. E. to the S. S. W. occupying the depressions which the natives call "bayirs." The shores of the Tarim here are very flat, and it is evident that the river is constantly seeking new channels; the little accumulations settling on the shores are constantly menaced by the waters, but the Chinese protect them by dykes. The labyrinth of lakes and marshes and river arms forming the delta of the Tarim is extremely complicated. Many of these lakes were listed on the chart and their soundings given. Since the first voyage of Dr. Sven Hedin, new ones have formed. To-day the principal arm of the Tarim, traversing several of these recent lakes, pours the waters of the river into the depression of Kara-Koshoon.

By the observations which he made as to the form and the new course of the Tarim, Dr. Sven Hedin has definitely solved the problem of the position of Lob-nor; a long discussion had arisen on this subject toward the end of 1878, between the geologist von Richthofen and the Russian explorer Prjevalski, The German savant located the Lob-nor, according to the Chinese maps, north of the lake discovered by Prjevalski. In reality the lake had shifted south.

Leaving the Yangi-Köll at the end of May, Sven Hedin reached Abdal by the principal arm of the Tarim. In descending the river he came very near being the victim of a fearful tempest on one of the shallow lakes which he found there. The heavens were black and the winds lashed the waves to foam. From the region of the lakes he made an excursion to the mountains; he visited Temir-lik, Gas-Köll and Mandarlik in a valley of the Tshimen-tag or Akato-tag, a word which signifies the mountain with the white pass.

The summer and fall of 1900 were given to a voyage of 93 days in the northeast of Thibet. This voyage was extremely trying in high regions devoid of all vegetation; one man perished there, as did also a part of the cattle of the caravan. Sven Hedin advanced toward the south up to 33 deg., 45 min. north latitude. He visited regions absolutely deserted and unknown except at a few points where he crossed his preceding routes. Going and returning he was able to analyze the orographic structure of the Kouen-loon Mountains and the complicated mountain system of Northern Thibet; he located a great many salt and sweet water lakes, navigated them and in some cases sounded them. Returning to the Temir-lik, he also took soundings of Koom-Köll. During the month of December, 1900, instead of resting from his dangerous tour of Thibet, he took up his travels again and for four months explored the Akato-tag, the Astyn-tag or Altyn-tag and all that part of the Gobi lying west of Sa-Tsheoo. He reached Altimish-Boolak, traversing desert and dry regions, where for 12 days he found not a drop of water.

He then explored more thoroughly the ruins which he had discovered in the preceding spring on the shores of the original Lob-nor and there found many curious wood-carvings, with elegant ornaments and figures of Buddha; he also found tablets of tamarisk wood covered with Chinese writing and dating from about 264-265 A. D. The city now ruined was in the third century of our era a station along the Chinese highway for caravans, which ran to Turkestan along the Tarim and of which the doctor found evident traces.

He then proceeded to more careful measurements of all the regions of the original Lob-nor and of the new lake, the Kara-Koshoon. He found that the Kara-Koshoon in its turn is moving and in this instance toward the north, in the direction of the former basin. The explorer was stopped in his progress by a lake newly formed, situated in the open desert between the former and the new Lob-nor; this made him make a detour of four days. This new lake is fed by a course of swiftly descending waters rising in the Kara-Koshoon.

In May, 1901, Dr. Sven Hedin resumed his trip and undertook the last and most important part of his programme of exploration. Like many others, he also allowed himself to be attracted by the mirage of Lassa, the forbidden city; leaving Abdal, he returned toward Thibet. Again it was necessary to climb the towering Arka-tag. This effort was rendered excessively dangerous by the glaciers and the abundance of snow. Between the successive ridges nothing was found except sterile and rocky valleys. The highest crests are almost needles and the descent, made through dizzy defiles, alongside of lakes and torrents, in the midst of hummocks of snow, was full of danger. The snow and the rain had transferred the soil into a liquid slime made up of sand and mud, through which the camels floundered and which made the journey insufferably hard. At last the caravan emerged from this maze of cliffs and lakes and reached the beautiful pastures near the Dang-la Mountains, where they camped.

Leaving the bulk of his caravan in this place Sven Hedin journeyed on the 27th of July toward the mysterious capital of the Dalaï-Lama, accompanied by a Mongol lama and a skin-clad Cossack; he himself was disguised as a Mongol. But Thibetan hunters caught sight of him and reported his march toward the south. Hence, nine days later, when he halted north of Tengri-nor, he was arrested, at night-fall, by Thibetan warriors. The explorer and his comrades were visited by the "Bombo" or governor of Naktshoon who by the order of the Dalaï-Lama treated them kindly, but forced them to return to their caravan under an escort. They reached it on the 21st of August.

Dr. Sven Hedin did not despair of attaining his end. In September he made a new attempt toward the Buddhist capital which seemed almost to be reaching for the impossible. The caravan was surrounded by a body of about 500 Thibetan horsemen, who compelled them to return. The explorer then took the direction of Ladak, avoiding the routes already followed, and taking scientific notes of the country traversed. He reached Leh December 20, 1901, made a short excursion to India and, wishing to complete the circle of his journey, again traveled to Turkestan across the difficult territory of Karakoroom; passing by Shahidoola and Kargalik, he arrived at Kashgar on the 14th day of May, 1902.

This stirring and perilous voyage has furnished very considerable scientific results, especially pertaining to physical geography. The cartographic material brought back comprises 1,149 sheets which, placed edge to edge, would have a length of more than 300 meters. The charts represent a journey of 10,500 kilometers in round figures, of which 9-10 cover hitherto unknown regions. The astronomical and meteorological observations, the geological researches and those relating to the fauna and flora, the study of the lakes, all contribute to make this long and venturesome exploration one of the most valuable yet made in the heart of the vast Asiatic continent, in those regions which are most mysterious and inaccessible.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from la Revue Universelle.

TRADE NOTES AND RECIPES.

Cement for Knife Handles.—

Rosin	600
Sulphur	150
Iron filings	250

Pour the mixture, hot, into the opening of the heated handle and shove in the knife likewise heated.

Furniture Polish.—The following formula for a new furniture polish comes from the Oesterreichische Farben und Lack Zeitung: White wax, 2,500 parts; water, distilled, 4,500 parts; potassium carbonate, 25 parts; oil of turpentine, 4,000 parts. Boil the wax in 1,500 parts of the water, carrying the potassium carbonate, until the wax is saponified. Add sufficient water to replace that lost by evaporation, and stir till cold and add, little by little, under constant agitation the oil of turpentine, and continue to stir until a complete emulsion is attained. When this occurs add the remainder (3,000 parts) of water all at once and stir in. In case the mixture is incomplete, add a little more oil of turpentine. Perfume with lavender oil. To use the cream, smear a little of it on a thin soft rag, and with this go over the furniture, then polish with a woolen cloth or bit of flannel. The cream answers equally well for leather upholstering, imitation leather, leather cloth, marble, etc.

New Process for the Manufacture of Fish Fertilizers—The fish fertilizers on the market have much less value than natural fertilizers, like guano. The reason is that the material obtained from fish is poorer in soluble nitrates and phosphates than the natural guano, and that it is in an imperfect state of division. M. J. Carstairs claims that fish contain all the elements of the best guano, and its inferior value is due to the loss produced in the manufacture. He has adopted the following method of preparation, consisting essentially in submitting the fish, dried and reduced to pieces, in an appropriate extractor, to the action of a mixture, in the state of vapor, of a solvent of the oil or a mixture of such solvents.

The solvents, according to him, may be classed in three groups: Group A: Carbon bisulphide, ether, benzol, benzoline, etc. Group B: Ethylic or methylic alcohol, or a mixture of these. Group C: Acetone, etc.

The rôle played by the substances of Group A is well known. Alcohol, at the temperature at which it is vaporized, converts the soluble albuminoids into insoluble albuminoids, and thus prevents them from mingling with the oil, to the detriment of its quality and its nutritive value as a fertilizer.

The action of alcohol has as a result the solidification of the albuminoids, which otherwise would be converted into a jelly, so that the fish, freed from the oil and taken from the extractor, are brittle and may be reduced to any state of division desired by means of an appropriate machine.

On the other hand, acetone, although this has in itself but a slight dissolving power for animal fats, considerably increases the action of the solvents, even when it is employed in small quantities.

The proportion of the mixture to be employed depends on the special substances of Groups A and B. When benzoline and methylic alcohol are made use of, the most suitable proportion is benzoline, from 80 to 85; alcohol, 12 to 15; acetone, 3 to 5.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT, from La Revue des Produits Chimiques.

An Intaglio Engraving from a Line Drawing—Mr. A. J. Newton suggests in the Process Photogram a method of engraving intaglio from a negative, or engraving in relief from a positive. He finds it to work excellently in practice. It should prove valuable to intaglio engravers or the makers of intaglio blocks for embossing purposes. Here is his description of his process: An ordinary line negative can be printed in the usual way with bichromated albumen on zinc, rolled up with transfer ink, developed and dried, and flowed with the enamel solution (dry enamel formula from Austin's Practical Half-tone):

No. 1.		
Rock candy	1¼	ounces
Bichromate of ammonia	½	ounce
Water	4	ounces
No. 2.		
Albumen	3	ounces
Water	4	ounces
No. 3.		
Chromic acid	80	grains
Water	1	ounce
Ammonia (aqua) 880	1½	drachms

Mix these separately as indicated above, then add No. 1 to No. 2, and stir thoroughly, after which No. 3 is to be added and the whole carefully filtered. After the plate is coated, whirl as usual, dry and burn to a brown color. When cool, sprinkle turpentine over the plate and rub vigorously with a pledget of cotton wool, when the ink lines will come away, carrying the overlying enamel, leaving the metal bare where the lines were. He adds the following hints: The plate should only be lightly inked. It has been suggested to me that in order to make quite sure that the enamel shall flow easily over the inked lines, and not leave any fine detail, the image should, after developing and drying, be dusted over with fine powdered graphite. I find this answers well. Also, in order to make quite sure the metal is clean, so that the enamel takes well, the plate may be given a slight etch in a one per cent nitric acid bath. The enamel should be allowed to dry gradually before burning in, as otherwise it is liable to crack. Other enamel solutions would do, but few resist nitric acid so well. It is better to burn but lightly, before cleansing out with turps, and after, to burn in again to a deeper brown color.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Windmills in Siam.—Pursuing the subject of the need of American agricultural implements in the great Klong Rangsit rice district of Siam,* I quote from letters from Mr. Y. S. Sanitwongse:

"A sample windmill, if sent to this country so that the farmers could see it working, should be made completely of galvanized steel—16 feet in diameter—and should be suitable for transmitting power, so that it can be used for irrigation in the dry weather and for husking and milling rice for home consumption during the planting and wet season. I will be glad to put the mill on my place in Klong Rangsit and let the people see what it can do.

"The offer made in a former letter to you † that rice growers would be willing to share half the profits with any party who would plow the fields and reap and thrash the rice for them by machinery has not been taken up in America, no doubt partly on account of the remoteness of this country from America and partly because of the uncertainty of getting sufficient remuneration for the trouble and expense. I am therefor desired to ask you what will be the expenses for an expert in such matters to come here and study conditions, so that if machinery is ordered there will be no failure."

This gentleman is the business manager of the great irrigation scheme and a large owner of real estate. He wants an opportunity to demonstrate what a good windmill can do in the district. This vast plain depends upon the rains for the one crop secured during the year. By the aid of windmills, there should be two crops a year and possibly three. The land is so level that the water is easily confined by dikes of a foot in height, thrown up around the small fields; and the soil is so clayey and adhesive that the water soaks very slowly through the earth. The fields are so near the level of the canal water that only the slightest lift is necessary to supply them.

The dry season extends from the 1st of November to the 1st of May every year, and during that time there is scarcely a day that sufficient wind is not blowing to furnish all the power needed for a mill. During this season, the soil is in such a condition that any of our agricultural implements could be used on the fields for plowing, harrowing, or even for reaping. Trade in farm implements may result from this endeavor, but after having been over the ground a second time, I should emphasize the opportunity for the right people that is represented in the offer to share half the profits of the year's crops with a party who will plow the fields and reap and thrash the rice. —Hamilton King, Consul-General at Bangkok.

Exhibition of Alcohol Appliances at Lima.—The Exposition of Alcohol Appliances for Industrial Purposes was opened by the President of Peru on February 28, and continued during the month of March. The object of the exposition was to create a new demand for alcohol, so that the greater consumption of this article, when applied to industrial purposes, would form a new source of revenue to the owners of sugar-cane estates, in view of the decrease in value of cane sugar.

The various appliances were arranged in the exhibition palace. The first hall was occupied by a German exhibit, contributed by the firm of Heckmann & Waldispühl, established in Lima. Their exhibit consisted of the following machinery:

(a) A 2½ horse power vertical motor, system Dürr, Berlin.

(b) A 6 horse power vertical motor, system Swiderski, Leipzig.

(c) Six motors from the Gasmotoren Fabrik, Dresden, of Moritz-Hille, placed in the order of power developed—i. e., 1¾, 3¾, 5, 7, 8, and 9¼ horse power.

(d) A 6 horse power motor from Gebrüder Korting, Kortingsdorf bei Hanover.

The 9¼ horse power motor was belted to a shaft 50 feet long, from which power was transmitted to several carpenters' machines, water pumps, and a printing press.

The Swiderski factory also send a 20 horse power transportable motor, for use in driving agricultural machines. Here it was exhibited for working cotton gins. The belting used on all this machinery was supplied by the firm of Jokamann Biertz, of Rhenish Prussia, which also had a tasteful exhibit.

In the gardens behind the palace was a narrow-gage railway about 6,000 feet in length, over which ran a train of several cars hauled by a locomotive of the Deutz system, which, though only of 4 horse power, can pull 25 tons on the level at any speed up to 5 miles per hour. It is intended for use in cane fields, mines, etc., where light portable railways are used.

Another notable exhibit of Messrs. Heckmann & Waldispühl consisted of brilliant alcohol lamps.

In another hall were the exhibits of the firm of Ludowieg & Co. Here were shown two motors of 8 to 12 horse power and of 15 to 20 horse power, respectively, made by the Motorfahrzeug und Motorenfabrik, Marienfelde Cein, Berlin. Each of these motors had a large water-cooling tank, carrying sufficient water for ten hours' work, which specially adapts them to agricultural work in places where water is difficult to obtain.

There were several stoves for heating rooms, made by C. F. Kindermann & Co., of Berlin, and also a number of smaller articles, such as spirit stoves, cigar lighters, etc., from the factory of Hermann Weissenburger & Co., of Cannstadt.

In the left wing of the palace was the exhibit of Siemens & Halske, who had on view a Deutz motor of the system Otto, of 6 nominal horse power, which can be raised to 12 horse power. The motor has a governor by which the consumption of alcohol is automatically regulated, in proportion to the power developed and the number of revolutions required. It drives two dynamos, one of which lighted several arc lamps and the other gave power to an electric motor operating a rock-drilling machine.

Close by was an exhibit of a 5 horse power kerosene motor of English manufacture; also another of 2½ horse power, a Webster, of American manufacture. They were driving small cane mills and carpenters' machines.

The Technical Society for Industrial Appliances of Alcohol, established in Paris, exhibited a powerful locomobile and two automobiles; also a bicycle and a tricycle operated by small motors placed in the framework.

To the right of the entrance was an exhibition of powerful lamps (some of 1,000, 1,500, and 2,000 candle power), lighted by alcohol, which formed part of the exhibit of a committee of French manufacturers, who also contributed a simple and easily transported bakery heated by a small consumption of alcohol, as well as two small motors—one of 5 and the other of 7 horse power—which were driving small machines employed in the process of bread making.

This exposition has been of great importance to Peru and will lead to the introduction on an extensive scale of alcohol and kerosene motors, and there is no reason why American makers should not secure a large portion of this business.

The exposition has shown that, notwithstanding the excellence of the alcohol motors exhibited, these cannot attempt to compete with those in which petroleum is used as combustible, because petroleum can be procured here at very low cost.—Joseph C. Cree, Vice-Consul at Callao.

Exposition for Laborers' Welfare in Germany.—My report on the Exposition for Laborers' Welfare in Germany* having evoked inquiries from the United States for further data, I give the following additional details:

The exposition building is situated at Charlottenburg, Frauenhoferstrasse 11-12. Employers, manufacturers, and inventors of new apparatuses for the prevention of accidents will be allotted space for exhibiting their contrivances free of charge. The articles shall be exhibited either in the form of a model or in natural size, and the machinery, when provided with electric motors, shall be exhibited in operation. For the necessary power, no charge will be made. The management will provide competent parties to give visitors instructions as to the working of the machinery, keep it in condition, and see that it is properly guarded, but will not be responsible for any theft or damage to the exhibited articles, for which the employes of the exposition are not responsible.

The expense of transportation to and from the exposition, as well as the mounting of machinery, when necessary, must be borne by the exhibitor.

Concerning the admission of exhibits, the management will decide after consultation with a committee to be appointed by the Chancellor of the Empire. When it appears that articles exhibited can be replaced by later inventions or improvements, or are not practical in their applications, owners will be requested to remove them.

It would seem that both employers and laborers will derive benefit from the exposition, while trade inspectors, etc., will be aided in the fulfillment of their duties. The exposition will probably be of particular value for engineers and technologists.—Joseph J. Langer, Consul at Solingen.

Pier at Almeria, Spain.—The Alquife Mines and Railway Company Limited, is constructing a pier at the east end of the harbor of Almeria, 450 feet outside of and parallel to the Levant mole.

This pier will be used exclusively for loading iron ore and will be the largest of the kind on the coast of Spain and probably on the Mediterranean. The contract price is $500,000, and the pier will be ready for use next January. The contractors are Alexander Findlay & Co., Limited, Motherwell, Scotland.

The present method of loading iron ore in Almeria is both costly and laborious. The ore is brought by rail and deposited in the station yard; thence it is carted to the mole, and after another handling the boats are loaded. The distance from the railroad to the dock, where most of the ore is placed on board vessels, is about a mile. One company loads from lighters.

The total length of the Alquife pier when completed will be 1,800 feet. The first 240 feet of the pier is carried on an earthwork embankment, with retaining walls on each side. For the next 600 feet there is a viaduct, consisting of eight masonry arches and three steel-work spans, one crossing a low, level siding and two passing over streets. The railway is then carried onto a viaduct (with seven steel towers and eight spans, each averaging 60 feet), and then onto the pier proper, which is 360 feet long.

The approaches are on a gradient of 2¼ per cent, made necessary to reach the pier proper at a level of 61 feet above mean water. The tide is almost neglected, as it has a rise and fall of only 2 feet.

The pier and steel towers are built on steel cylinders, 110 in all, filled with concrete. These cylinders are sunk to such a depth that by means of a little dredging toward the shore end of the pier steamers drawing 26 feet may come alongside with safety. The west breakwater of the harbor protects the pier in a great measure from the westerly winds, while the easterly winds never cause inconvenience.

The chief features of the work are two mineral deposits on the pier proper, capable of holding about 4,000 tons each. These deposits are located on each side of the pier, and the mineral is poured into the steamers by chutes 16 feet long. There are 10 chutes on each side. A vessel of average tonnage can be loaded in two or three hours, whereas by the present method six to nine days are usually consumed. The company plans to export 300,000 tons yearly, and it estimates a saving of $100,000 a year.—A. E. Carleton, Consular Agent at Almeria.

Advice to Exporters and Emigrants to Brazil.—This consulate receives a great many inquiries from United States manufacturers and business men for the names of firms here handling special lines of goods, and always does its best to supply information. The firms whose names are given are probably inundated with circulars, catalogues, and letters, which promptly find their way to the waste basket.

Firms here are very conservative, and once a particular mark or brand is known and found to be suitable and reliable it is very hard to displace it. Business men will not send orders to people whom they do not know; it is only natural that merchants in Brazil should be as suspicious of merchants in the United States as the American merchants are of them. The only way to cultivate trade in South America is by personal effort and contact. Our exporters will have to send out competent men and locate representatives in the principal markets. Trade here must be built up on the same lines as in the United States—by patient, unremitting effort and honest, just dealing. The language of Brazil is Portuguese, but salesmen speaking Spanish can get along easily. To accomplish much, however, agents must understand one or the other of these tongues.

Just now Brazil is pasing through a season of severe financial depression, but the resources of the country are such that matters must mend some day, and there is no good reason why the United States should not secure a fair share of the vast trade which will then be done.

Inquiries also come from people who propose settling in Brazil as farmers. It cannot be too distinctly understood that such a course will entail disappointment and, very likely, disaster on all who make the attempt.

It should be remembered that local conditions of climate, language, and custom present great difficulties for those who have been brought up in other surroundings, and it is not likely that American farmers could readily adapt themselves to the change.

Many letters come desiring information as to persons who are supposed to have died, leaving almost fabulous fortunes which the Brazilian government is holding, pending the appearance of the heirs. Brazil is not a custodian for any such fortunes.—L. C. Irvine, Vice-Consul-General at Rio de Janeiro.

Trade of Liberia.—The following has been received from Minister Crossland, of Monrovia:

It is next to an impossibility to procure statistics regarding the trade of Liberia, as there are no printed data. The imports amount to nearly a million dollars. As nine-tenths of the civilized people are Americans by birth or descent, United States goods and wares are preferred to any others, but no United States steamer or trading vessel touches at Liberia. Holland, with a direct line of steamers and with commercial agents here, ranks first in commercial matters. Germany leads England in trade. Two steamers from Hamburg call at Liberia per week.

The chief products are coffee, ginger, palm oil, palm kernels, and cam wood. They have declined in price during the last few years. Rubber figures once more on the list of exports, and fiber is undoubtedly on the increase. The following statement shows the value of the commerce in certain districts for the fiscal year 1900-1901:

District.	Imports.	Exports	Total.
Montserado	$85,023	$7,771	$92,794
Grand Bassa	58,775	23,636	82,411
Sinoe	17,133	5,309	22,442
Maryland	29,278	10,940	40,218
Total	190,209	47,656	237,865

Exposition of Photography at St. Petersburg.—Under date of April 23, 1903, Consul-General W. R. Holloway reports as follows:

The St. Petersburg International Exposition of Photography was opened to-day. It consists of six sections, the largest and most interesting of which is the one devoted to artistic photography. It includes exhibits from France, Italy, Belgium, England, and America. Especially good photos are sent by the Parisian Photo Club, the Turin, London, and New York camera clubs, and the Belgian Club of Amateurs' Photographs. Germany exhibits a beautiful collection of private photographs. The Russian section is well represented by the Moscow, Kazan, Samara, and Kief photographical societies, as well as by amateurs. The section of the photomechanical press proceedings is rich in exhibits of the St. Petersburg office for preparing government papers, and of Angerer & Geshl, of Austria; Malvo, of Brussels; Unia, of Prague; and many other firms. Other sections are not less interesting, and give evidence of the great progress in photography during the last few years.

New German Cable.—Consul J. F. Winter writes from Annaberg, April 28, 1903:

On March 23 last, the German-American Cable Company commenced laying a new cable between Emden and New York by way of the Azores. It is expected that it will be completed by the end of the present year. Emden is the new German port which has the advantage of lying nearest to New York. This enterprise will tend to lessen cable rates, and will be a step toward the plan of making Germany independent of foreign cables.

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No. 1655, May 25.—*Tunnel Under the Seine—*Pier at Almeria, Spain—*Advice to Exporters and Emigrants to Brazil—Launch Service in Costa Rica—Trade Statistics at Cienfuegos—Railway Freight Rates in Germany—*Wireless Messages from Moving Railroad Trains.

No. 1656, May 26.—Caper Culture in France—Hydraulic Lock in Ontario—German Commerce with Canada—Trade Information from Spain—Dividends of German Steamship Lines—Vintage of Germany in 1902—*Exposition at Sivas, Turkey.

No. 1657, May 27.—Tariff of British Guiana.

No. 1658, May 28.—*Exhibition of Alcohol Appliances at Lima—Changes in Chemnitz Hosiery and Glove Export—*Exposition for Laborers' Welfare in Germany—*Trade of Liberia—*Exposition of Photography at St. Petersburg—*New German Cable—*Request for Trade Information.

No. 1659, May 29.—German Chambers of Commerce—New Suit Protector Against Live Wires—Tariff Changes in Venezuela.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

* See Advance Sheets Nos. 1300 and 1330.
† See Advance Sheets No. 1300 (March 27, 1902.)

* Advance Sheets No. 1546 (January 16, 1903).

SELECTED FORMULÆ.

Insect Destroyers.—To destroy bedbugs the following among other preparations have been recommended:

Soft soap	100 grammes
Caustic soda	15 grammes
Water	1,400 grammes

A mixture of soap and turpentine has also been recommended, the object of the latter being to coat the eggs and prevent their hatching. The following formula is suggested:

Soft soap	200 grammes
Turpentine (gum)	50 grammes
Hot water	650 grammes

Dissolve the soap in the hot water, add the turpentine and stir till cold.

Insect powder obtained by grinding the flowers of certain pyrethrums may prove effective.

For roaches, a poison which is practically harmless to man may be made by the following formula:

Borax	9 ounces
Starch	2½ ounces
Cocoa	1 ounce

Another preparation not so inactive as to human beings is made by mixing:

Angelica root, in fine powder	5 ounces
Oil of eucalyptus	1 ounce

Scatter at night plentifully around the haunts of the pests.

Insect powder is also used as a destroyer of roaches. The observations of some experimenters seem to show that the poisonous principle of these flowers is non-volatile, but our experience indicates that these observations are not complete, as the most favorable conditions under which to use them are in a room tightly closed and well warmed. There may be two poisonous principles, one of which is volatile. Disappointment sometimes arises in its use from getting powder either adulterated, or which has been exposed to the air and consequently lost some of its power. When a good article is obtained and used plentifully under the conditions above indicated, it proves very efficient.

An objection to the foregoing method is the great dust which it makes. This dust sometimes proves irritating to the mucous membranes of the one applying the powder, and also makes a "mess" in the room. To avoid this, a tincture might be made from it and applied by means of a spray atomizer.

We would add that persistence in the use of any means is an important element in the work of destroying roaches. A given poison may be employed and no visible result follow at first, when in reality many bugs may have been destroyed, enough being left to deceive the observer as to numbers. They multiply very rapidly, too, it must be remembered, and vigorous work is required to combat this increase. Where they can easily migrate from one householder's premises to those of another, as in city "flats," it requires constant vigilance to keep them down, and entire extermination is scarcely to be expected.

A fly poison which is harmless to man may be made from quassia wood as follows:

Quassia	1,000 parts
Molasses	150 parts
Alcohol	50 parts
Water	5,750 parts

Macerate the quassia in 500 parts of water for 24 hours, boil for half an hour, set aside for 24 hours, then press out the liquid. Mix this with the molasses and evaporate to 200 parts. Add the alcohol and the remaining 750 parts of water, and without filtering, saturate absorbent paper with it.

This being set out on a plate with a little water attracts the flies, which are killed by partaking of the liquid.

Insect powder is said to be an effective destroyer of ants, as it is of beetles. Ground mustard accidentally spilled on the floor of a pantry and allowed to remain for some time drove ants away. Sulphur is said to prove similarly distasteful to them. Oil of cedar and coal oil also drive them away. Borax would probably prove fatal to ants, if they could be induced to eat it. This might be accomplished by mixing it with sugar; or they might be attracted by the cocoa mixture, a formula for which is given above.

Where ants select a particular point for their incursions it would be a good plan to surround it with a "fortification" of obnoxious substance. Sulphur, mentioned above as being distasteful to them, has been used successfully in this way, we are told; and so has coal oil. The latter, however, is not a desirable agent, leaving a persistent stain and odor.

In the extermination of ants, as of roaches, persistence is a factor of great value, and failure of agents which have proved useful elsewhere may be due to a want of this factor.

To destroy insects on house plants the following is proposed:

Soft soap	4 drachms
Quassia	72 grains
Salicylic acid	30 grains
Alcohol	5 ounces
Water, sufficient to make	24 ounces

Mix and macerate several days, then filter and add the water. Apply with a brush or plant sprinkler.

For protection against all non-masticating and many mandibulate insects, kerosene oil is much used. It is exhibited in the form of an emulsion, which may be made as follows:

Kerosene oil	2 gallons
Common soap	8 ounces
Water	1 gallon

Dissolve the soap in the water by the aid of heat, bring to the boiling point and add the kerosene in portions, agitating well after each addition. This is conveniently done by means of the pump to be used for spraying the mixture.

For destroying scale insects dilute this emulsion with 9 times its volume of water; in the case of most others, except lice, dilute with 14 volumes, and for the latter with 20 to 25 volumes.—Drug. Circ. and Chem. Gaz.

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